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Effect of Storms on a Lake Breakwater

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The interesting article in Engineering News, Dec. 22, 1910, on "The Fishery Harbors of Scotland," shows a picture of the harbor at Aberdeen with spray thrown to a height of 100 ft. By way of comparison and as an illustration of wave force on harbor structures on an inland lake the accompanying views of Ludington Harbor, Mich., may be of interest.

Ludington Harbor is on the east shore of Lake Michigan about midway in its length north and south and has greatest exposures of about 160 miles from the south and southwest, 80 miles from the northwest, and 60 miles from the west, the width of the lake at this place. The harbor entrance from Lake Michigan to the sheltered inside lake (Pere Marquette Lake) is a channel about 2500 ft. long protected by timber piers and revetments with an entrance width of about 270 ft. narrowing to about 180 ft. at the inner end, and a navigation depth of 18 ft. A plan of the harbor is shown in Fig. 3.

Two breakwaters, 400 ft. apart at the outer ends and diverging at an angle of 90°, each 1800 ft. in length, were begun in 1908 and completed in the spring of 1911. These breakwaters with shore connections yet to be built from the inner ends of each to the shore line, form a protected entrance to the inside piers. To provide proper sea room between the two entrances, about 500 ft. of the outer ends of the inside piers will be removed. At the time of construction, the depths, below mean lake level, were about 25 and 35 ft. at the outer ends, and 15 and 20 ft. at the inner ends, respectively, of the north and south breakwaters.

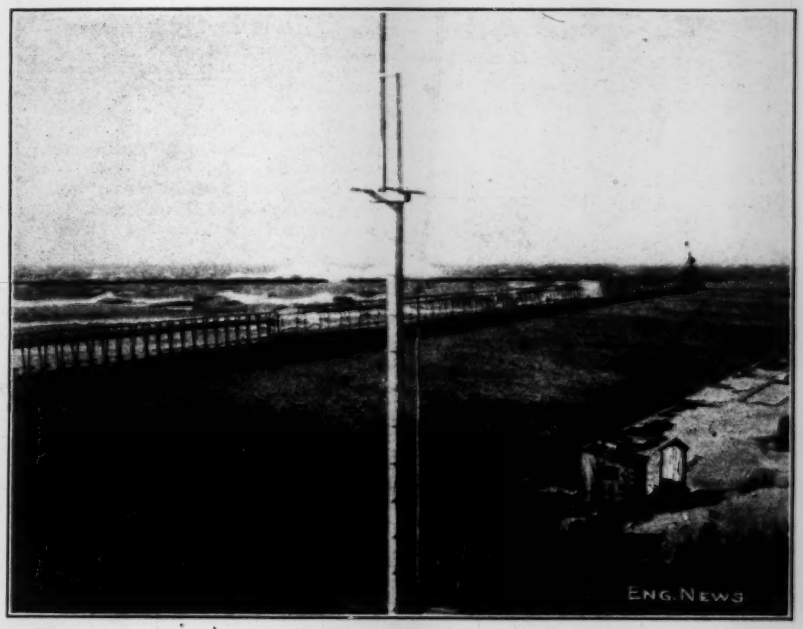

Fig. 1. Storm of Oct. 30, 1910, at Ludington Breakwater, Looking across Inside Piers to South Breakwater

(Outer waves approach 60 ft. in height).

Each breakwater consists of 18 timber cribs, each 100 ft. long and 30 ft. wide, surmounted by a 6-ft. superstructure with vertical side walls. The cribs, with tops at mean lake level, vary in depth from 24½ ft. and 26½ ft. at the outer ends to 16½ ft. and 18½ ft. at the inner ends, respectively, of the north and south breakwaters; each crib rests on 84 foundation piles in four rows of 21 piles each. Each crib has two interior longitudinal walls dividing the crib into one interior row of pockets 12 ft. wide in the clear, with grillage bottoms carrying a permanent load of stone, and two side rows of pockets each 7 ft. wide in the clear with open bottoms to allow the escape of stone in case of scour. There are 11 cross-walls, including the two end

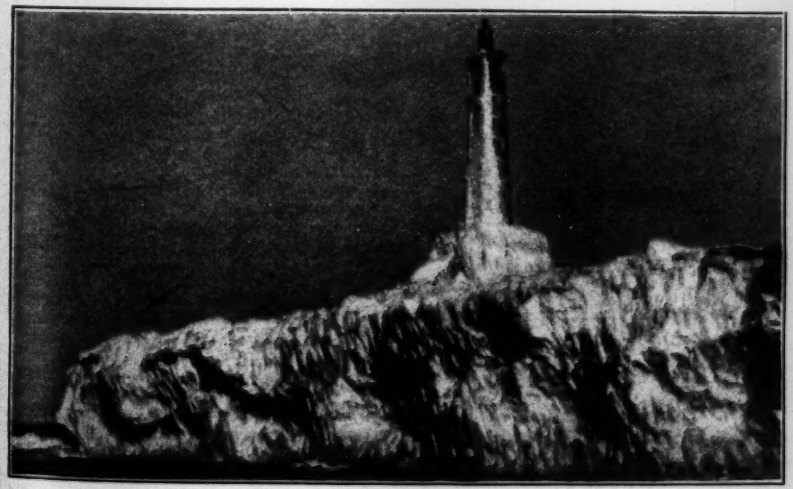

Fig. 2. Ice Coating on Lighthouse at End of South Breakwater

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walls, dividing the crib into 10 pockets 9 ft. long in the clear except the end pockets, which are 6½ ft. long. Between these cross-walls in the top course of the superstructure are intermediate cross-ties to support the longitudinal deck, making clear spans of 4 ft. for the 6x12-in. pine deck. Aside from the deck the timbers in the crib are 12x12-in. sticks, hemlock below water, southern or Norway pine above water, and oak vertical posts at the ends of the cross-walls.

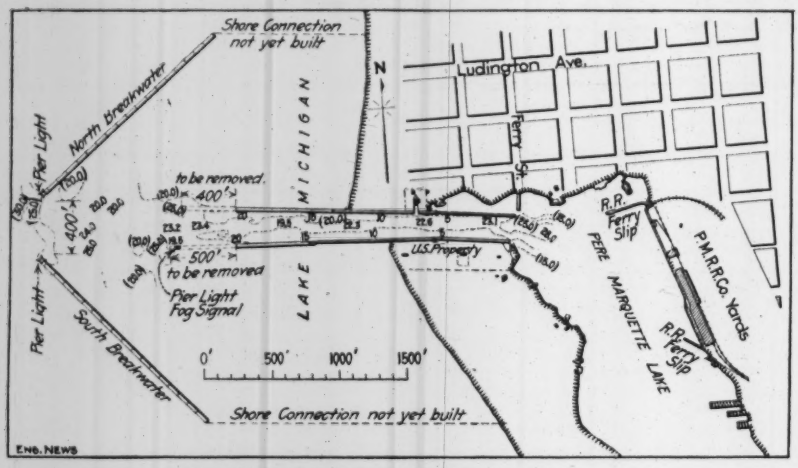

FIG. 3. BREAKWATER AT LUDINGTON, MICH.

During an unusually severe storm in October, 1909, and other storms of the following two months, the south breakwater was badly damaged. Cribs 5 and 6 (500 and 600 ft. from the outer end) suffered the most due to the absence of portion of the south breakwater looking toward the outer end and shows the 6x12-in. deck and the 12x12-in. supporting timbers in the cross-walls broken by the sea, the vacant places from which the deck was carried away and the base of the concrete pedestal for the harbor light at the outer end from which the gas tank on the left-hand side was torn away.

FIG. 4. LUDINGTON, MICH., BREAKWATER AFTER SEVERE STORM

(6x12-in. deck and 12x12-in. crossties broken by sea and heavy deck carried away in places.)

The south breakwater during storms is shown in Figs. 9 to 14. Fig. 1, taken Oct-

stone filling in the nearly completed superstructure, but other portions which were completed and decked suffered as well. Fig. 4 shows the effect of these storms. It is a view of the completed

30, 1910, is from the lookout of the L Saving Station over one-half mile aw on the north pier, looking toward south breakwater, which was then 17 ft. long. In the foreground is the en trance channel formed by the insi piers. An elevated walk on the sout pier extends to the pier light and fog signal at the outer end. This view shows the heavy sea striking the south breakwater and also the sea, after crossing the sheltered area, striking the south pier and breaking over the top of the elevated walk. At times, judging by the height of the pier-light, the top of the spray reached 60 ft. or more above the surface of the lake.

A view taken in February, 1910, Fig. 2, shows the ends of the south breakwater loaded with ice.

Engineers Must Have Characters above question. Millions are spent each year in the development of great undertakings, and the engineer's decisions may make or break a contractor. Remember that you are required to be the arbiter between two parties, and it is just as dishonest to make the contractor furnish more than the contract clearly calls for, as it is to allow him to do inferior work.

Character is the dominant factor in life. It is the only thing that leaves a permanent impression upon the men with whom you come in contact. Corporations and men of means are very careful as to whom they trust to spend their money, and unless your private life as well as your professional life will bear investigation, you will not gain the confidence necessary to enable you to reach the top of your profession.

It has been said that an engineer must be one-third mule to stand the work, one-third dog to stand the kicks, and one-third angel to keep cheerful, but I believe he only has to be all a man at all times.

To be a well rounded man you must take an interest in matters outside your calling. Take an active part in all the movements that are being carried on so nobly for the benefit of your fellowmen; be a leader in your community in religious and philanthropic work. Willingly give a portion of your time to help those who have not had your advantages. You will not find such time wasted, as it will prove as helpful to you as to those you are trying to help. Let us not be so engrossed with our worldly affairs that we forget that "the things which are seen are temporal, but the things which are not seen are eternal."

If you have faithfully lived up to your opportunities, and yet do not seem to make the progress you desire or deserve, don't be discouraged, and don't jump from one thing to another hoping that you will suddenly "hit it rich" by some lucky chance. To succeed you must know some one thing thoroughly, and this you cannot do if constantly changing, so select your calling and then stand by it, through hard times as well as good times, and eventually it will be known where an expert in your line can always be found.—[Extract from the commencement address at the Rensselaer Polytechnic Institute by H. W. Hodge, of Boller, Hodge & Baird, consulting engineers, New York City.]

A High-Power Passenger Locomotive

The high-power high-speed passenger locomotives required under modern conditions have approached pretty closely to the limit of weight permissible, and as three coupled axles are the maximum for high-speed service, locomotive design seems to be approaching a situation involving the use of special types of engines. To avoid such a condition it is essential to keep the weight at a minimum. To see just what could be done in reducing the ratio of weight to power in engines of ordinary type, the American Locomotive Co. has taken the progressive step of designing and building a locomotive for this particular class of service, with the special view to combine relatively low weight with high power. This engine's special features are described in this article.

With the ever increasing power of the modern locomotive, designed to meet the demands of traffic conditions, there has been, of course, an increase of weight, and the most economical design is that in which the weight per unit of power is reduced to a minimum without going below a limit which means high cost of maintenance, repair and renewals in service. The relation of weight to power in engines of the same class varies within a wide range, due to the variations in design and the individual opinions of the designers.

In order to make some practical determinations and tests as to this relation the American Locomotive Co. designed and built for experimental purposes a heavy passenger locomotive of the 4:6:2 class, and has had the engine in service on different railways under very close observation as to the results obtained. We are informed that in actual service the engine has developed 2216 hp. (or 1 hp. per 121.4 lb. of total weight), and that both in power and in the relation of weight to power this exceeds the record of any previous passenger engine. In addition this engine compared with a similar engine of equal weight has shown an economy of over 25% in fuel consumption. The engine is shown in Fig. 1, and its dimensions are given in Table I, p. 97. For information and drawings we are indebted to the builders.

Builder's Statement

This rather costly experiment involved a careful study of locomotive design, followed by a complete design for a special locomotive and thorough analysis of the design; and then the construction of an engine according to the plans thus developed. In explanation of the purpose of this experiment we quote below a statement furnished to us by the builders:

This engine (No. 50,000, builder's number) was developed in consequence of the thoroughly appreciated need of greater sustained capacity to meet the maximum requirements of modern passenger service. It represents an effort to determine the limits to which the efficiency and capacity of a passenger locomotive of a standard wheel arrangement could be developed, without exceeding conservative weight limitations, through the application of the latest developments in locomotive design and materials. In other words, to secure the maximum sustained capacity per pound of weight.

It embodies the latest knowledge of general proportions and the most recent developments in materials and improvements in the design of details, combined with the best use of approved fuel-saving devices to secure the utmost possible economy of the locomotive as a whole from the operating standpoint. Many improvements over long accepted conventional practice in the design and construction of some of the principal details introduced in this locomotive have since been adopted as standard practice by the builders and widely applied to a large number of other locomotives with marked success. For these reasons, this engine is considered as marking a distinct and definite feature in locomotive engineering.

The most pronounced and important lines along which progress in locomotive development has followed during the past year, are as follows: 1, careful attention by locomotive builders to the selection of correct proportions, based on data secured from recent exhaustive investigations; 2, revision and modification of conventional practice in the design and construction of standard details; 3, the application of fuel-saving devices with the view of securing from each device its fullest value in fuel economy and increase in capacity for the same amount of coal burned. This locomotive seems to represent the highest expression of this development. Untrammeled by any outside specifications or the necessity of conforming to the existing standards of any railway, the builders had a free hand to embody in this design their ideas of the best locomotive-engineering practice. This locomotive sets a new high mark for the capacity and economy attainable within the limitations of conservative wheel loads in a modern passenger locomotive designed for sustained high-speed service with heavy loads. It has also pointed a way by which present practice may be greatly improved by better proportion of boiler to engine capacity, greater refinement in the design of details and modifications of present standards, the best use of fuel-saving devices, and the latest developments in material. There is not another instance in the history of American locomotive development in which locomotive builders on their own initiative and at their own expense have constructed a locomotive to secure information as to the maximum possibilities in economy and capacity inherent in already adopted principles, with the view of the advancement of locomotive design.

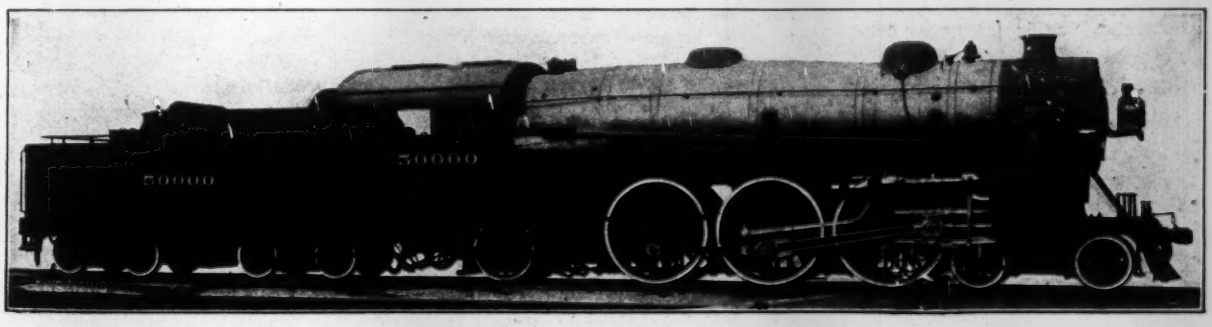

Fig. 1. Experimental Passenger Locomotive of High Power and Relatively Light Weight
(American Locomotive Co.; Designer and Builder).

Boiler and Superheater

We may take up now the consideration of certain features of the engine more in detail, and the first of these is the boiler design, since the fundamental feature of a locomotive is its boiler, or power generator. To accomplish the purpose of the design of the new engine (that is, to secure the maximum capacity per pound of weight), it was essential to secure the largest boiler capacity within the determined wheel loads. This aim was attained in three ways: 1, by eliminating every possible pound of weight that was not necessary to strength or durability; 2, utilizing the weight thus saved to provide a larger boiler, and 3, increasing the capacity of the boiler thus secured by combining in its design the most approved fuel-saving devices to obtain the utmost economy in boiler and cylinder performance. In Table II is given a comparison of locomotive No. 50,000 with other leading examples of locomotives of the same type and of approximately equal weight. This shows the larger boiler provided in the new engine in proportion to its weight.

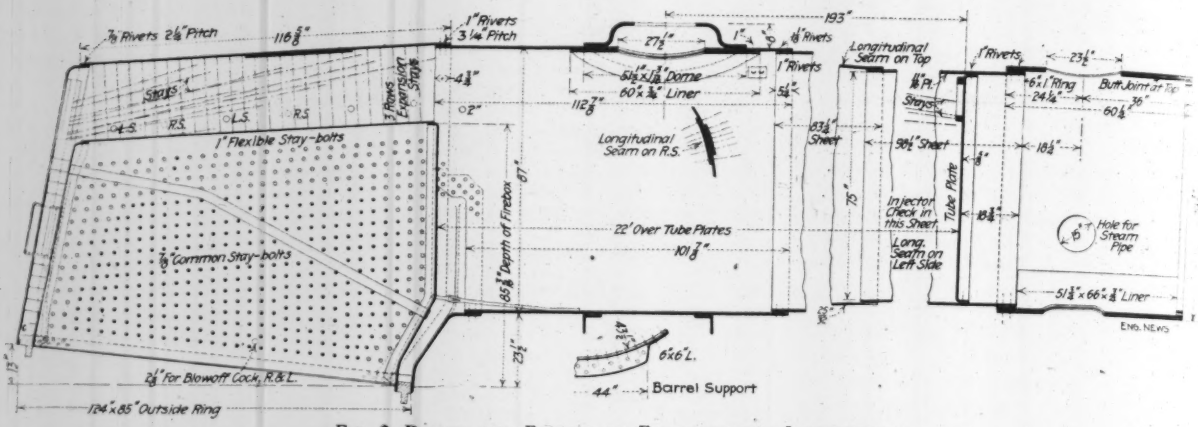

Fig. 2. Boiler and Firebox of Experimental Locomotive

In comparing the new locomotive, No. 50,000, with the other two superheater locomotives in Table II, it is to be noted that the boiler of the first has respectively 524 and 264 sq.ft. more evaporative heating surface, combined with 132 and 192 sq.ft. more of superheating surface than the other two, both of which are of equal or greater weight. Compared with the two locomotives not equipped with superheater, No. 50,000 has only 379 sq.ft. less evaporating heating surface, but this is more than counterbalanced by the economy secured with the 897 sq.ft. of superheating surface. It is stated that this is the largest amount of superheating surface provided in an American passenger locomotive up to the present time, and that it results in realizing greater economy in operation from this feature, due to the greater degree of superheat attained, as shown by test records.

Compared with another locomotive of equal weight, also equipped with superheater, but having less superheating surface and giving an average of 63° less superheat, No. 50,000 showed in service tests an average greater economy of 13% in fuel and 14% in water consumption per i.hp. per hour. In these tests, No. 50,000 reached a maximum superheat of 341° with an average of 276°, which is believed to be the highest record for any American locomotive.

The boiler, Fig. 2, is of the wagon-top type, with a single cylindrical course 8 ft. long next to the smokebox and a tapering course 7 ft. long. The barrel has bearings on the cross braces carried by the frames. The dome is very low, as is usual with such large boilers, and its inside height is only about 7 in. It is 33¼ in. inside diameter, of 1 7/16-in. metal, and flanged out to a diameter of 51½ in. so as to have two rows of rivets through the dome, shell and liner. The 27½-in. hole in the shell is reinforced by a ¾-in. liner plate 5 ft. diameter, which is riveted to the shell by an inside and outside row of rivets in addition to the two rows through the dome flange. The longitudinal seams in the barrel are butt joints with double straps. Behind the dome course the top slopes downward to the back head. At the smokebox end, the tube sheet is set back 18 in. from the end of the barrel, which has a ring 6x1 in. fitted between it and the smokebox shell. The bottom of the smokebox is reinforced by a liner for the saddle connection. Two holes in the sides provide for the passage of the steam pipes to the outside, and there is a 23½-in. hole in the top. The smokestack projects inside the smokebox, and has a flaring or trumpet-shaped lower end. No separate or adjustable draft pipe is used. The spark-arrester arrangement includes netting and deflector plates.

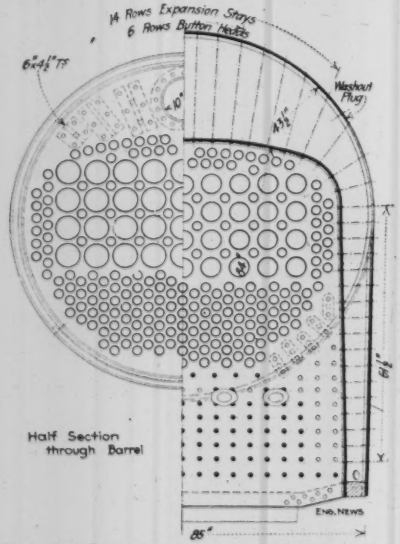

Fig. 3. Cross-sections of Boiler and Firebox, Showing the Superheater Tubes

The firebox (Figs. 2 and 3) is of the wide radial-stay type, mounted above the rear truck. The first three rows of crown stays are of the Tate expansion type, while Tate flexible staybolts are used in parts of the side sheets. The common staybolts are ⅞ in. diameter, with a ⅜-in. hole 1¼ in. deep drilled in the outer end. There are two fire-doors, with holes 15 in. diameter. To further increase the boiler capacity by means of high boiler economy, the firebox is equipped with a Security sectional brick arch, supported on water tubes. The superheater is of the Schmidt type, with top header and double-looped superheater tubes. It consists of 36 four-tube superheater units, the large tubes being 5½ in. diameter, arranged as shown in Fig. 3. A damper of the usual design automatically regulates the flow of gases through the superheater flues when the throttle is closed.

Other Features

Aside from the large boiler capacity, a number of new features were introduced in this design with a view of saving weight and securing economy in operation. Among these may be noted the

following: 1, cast-steel cylinders with cast-iron bushings; 2, steam pipes arranged to connect with the cylinders outside of the smokebox; 3, screw reversing gear; 4, self-centering guides for the valve stems, and a new arrangement of guides for the extended piston-rod ends; 5, improved outside-bearing radial trailing truck. Most of these features, modified somewhat in structural features, have since been adopted in the builder's regular practice and have been applied extensively on later locomotives. However, credit for them belongs really to locomotive No. 50,000, as it was the building of this experimental engine which led to their development.

A comparison of weights of certain parts for this engine and for an engine of the same class but of more ordinary design is given in Table III. In regard to this comparison it may be noted that the total weight of the boiler of the experimental engine is slightly greater than that of the other engine: 98,600 lb. as against 94,400 lb. But, on the other hand, the claim is made that the saving of weight effected in other parts of the engine (as shown in Table III) was utilized in providing a larger boiler, and that in this way there was secured a greater boiler capacity in proportion to the total weight than is secured in the average design of engines of the same class and size. The weights given above include the boiler complete (with firebox and tubes), all ready to be set in place upon the frames.

VALVE GEAR—The valve gear is of the Walschaerts type, now commonly used on large engines, and it is of interest to note that as far as weight is concerned there is little difference between this and the Stephenson gear. It has been generally assumed that saving in weight of moving parts was one of the essential advantages of this type of gear, but in American practice the parts have been strengthened and enlarged until the weight is about the same in both cases. In this engine, however, a new arrangement of the gear was adopted, which effected a saving in weight as compared with previous ordinary practice. This is shown by the list of weights in Table III.

FRAMES AND SPRING RIGGING—The frames (of vanadium steel) are of the double-bar type (6 in. wide) at the driving wheels, with single 5-in. slabs extending past the cylinder saddle and slabs also at the rear end. All driving springs are above the boxes, and are equalized together and with the springs of the rear truck. The front truck has the usual arrangement of inverted elliptical springs. All wheels are flanged, and the rear truck axle has a lateral play of ⅛ in. The distance between backs of flanges is 53⅛ in. for the main drivers and both trucks, and 53¼ in. for the first and second pairs of drivers.

PRESSED-STEEL PILOT—Another feature introduced in the aim to limit the weight of every part to a minimum consistent with strength, is a pressed-steel bumper and pilot, which has been employed successfully on the Lake Shore & Michigan Southern Ry. The bumper weighs about 1200 lb. less than an ordinary design of cast-steel bumper, while as between the pressed-steel and wood pilots there is a difference of 350 lb. Thus a total saving of some 1500 lb. is effected in these two details.

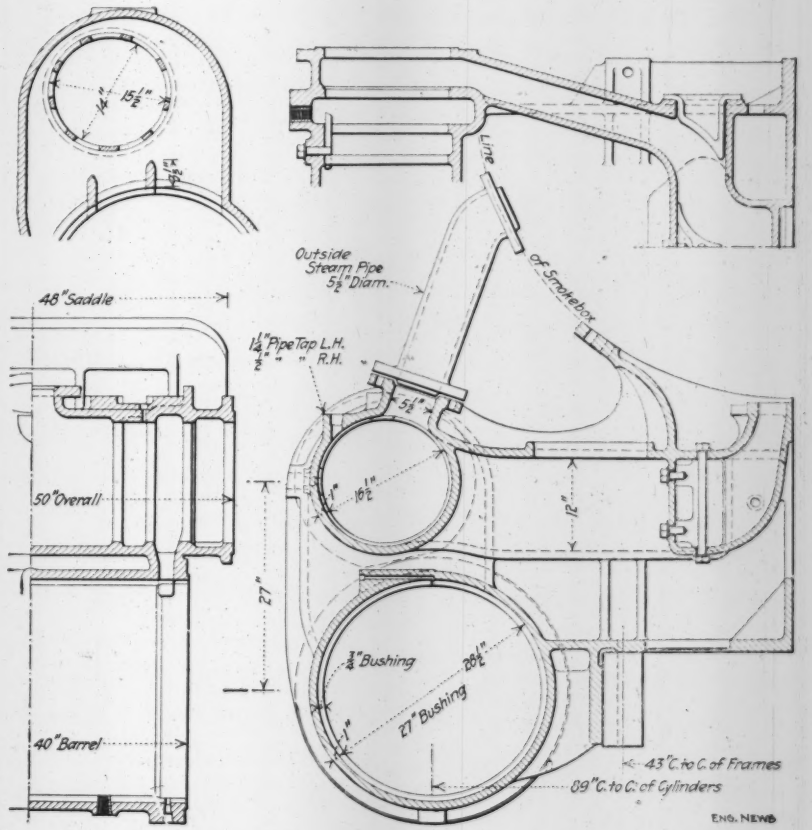

FIG. 4. CAST-STEEL CYLINDERS AND SADDLE WITH OUTSIDE STEAM PIPES

(The outside steam pipes enable the saddle design to be made much more simple than when steam passages are formed in it in the usual manner.)

VANADIUM STEEL—Additional strength without increased weight was secured in part by the liberal use of vanadium steel for many of the principal parts. These include driving-wheel centers, frames, rods, piston rods, valve motion, springs and crank pins. Vanadium was used also in the cast-steel cylinders and in the cast-iron bushings for the cylinders and valve chests.

CAST-STEEL CYLINDERS AND OUTSIDE STEAM PIPES

This is the first instance of the use of cylinders of this construction in American locomotive practice, and constitutes probably the most radical departure from conventional practice in this engine. This construction was adopted in order to save weight. The 27x28-in. cylinders weigh 2660 lb. less than cast-iron cylinders 22x28 in. of ordinary construction with cast-iron bushings. Further than this, cast-iron cylinders of this larger size for inside steam pipes would have weighed approximately 4000 lb. more. This outside arrangement of steam pipes was made necessary by the use of cast steel for the cylinders, as it was the only practical method of securing the required simplification of the castings. It will be seen by Fig. 4, that the design eliminates the central live-steam passages in the cylinder saddle, which are found in the ordinary construction of cylinders arranged for inside steam pipes. This greatly simplifies the coring of the cylinder and gives a direct passage of the steam from the dry pipe to the steam chest, while it will result probably in reducing to a minimum the cracking of cylinders in service.

The outside steam-pipe construction (Fig. 4) first introduced into this country on the locomotive here described is thought to have numerous advantages. It

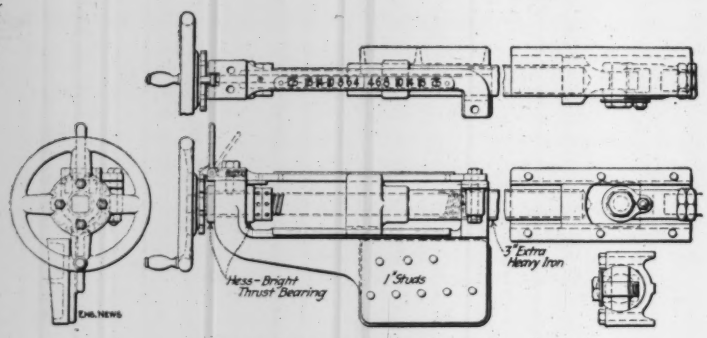

FIG. 5. SCREW REVERSING GEAR

improves the steaming capacity of the boiler because it removes much of the obstruction to draft in the smokebox which is present with the ordinary arrangement of steam pipes, and thus gives a greater clear area below the diaphragm plate. A better joint with the cylinders is also provided by the eight bolts of equal length, with the symmetrical flange, in place of the usual four or six bolts

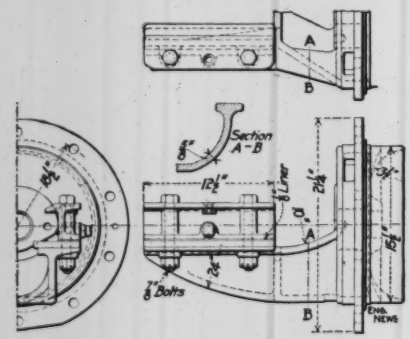

FIG. 6. SELF-CENTERING GUIDE FOR VALVE STEM (CAST ON THE BACK HEAD OF THE VALVE CHAMBER)

and style of flange adapted to inside pipes. Moreover, with this construction, should a small leak occur at the junction with the cylinders, it has no injurious effect on the steaming of the engine. Such a leak would result only in wasting steam, but would not interfere with the vacuum in the smokebox, as in the case of a similar leak with the ordinary inside pipe construction. The cylinders are spaced 89 in. centers, with the center lines 27 in. below and 4 in. inside those of the valve chambers.

SCREW REVERSING GEAR

The use of power reversing mechanism is common in foreign locomotive practice, but for some reason this has not received much attention in this country, and even on large engines it is usual to find the ordinary hand lever, the operation of which requires considerable muscular exertion. In fact it is well known that enginemen often fail to adjust the valves to meet the variations in running conditions, owing to the severe work involved. Not only this, but the ordinary mechanism is not capable of giving such close adjustment or regulation as can be obtained easily by the use of a screw or other power mechanism.

The use of the screw reversing gear on this engine therefore points to an important change in American locomotive practice, both from the standpoint of economy and ease of operation. With the increase in size and power of locomotives it is becoming more difficult to handle the reverse lever. As a result considerable loss in economy and efficiency in operation ensues from the fact that steam is not used expansively with full throttle and cut-off arranged at the most economical point. This is due in part to the fact that at high speed it is often a risk to change the reverse lever because of the liability of the lever getting out of the hands of the engineman. For engines other than the Mallet type, on which power reversing gear is used, the screw reversing gear offers a means of solving the present difficulties. This gear can be arranged to give about ten times the leverage obtained with the reverse lever as usually proportioned. Ball bearings are used to take the thrust of the gear provided in this design of screw reversing gear shown in Fig. 5, and in this way the amount of leverage absorbed by friction is reduced to a minimum. The wheel can be spun around very rapidly, so that the gear can be completely reversed in from four to six seconds. This is probably faster than can be done with the ordinary reversing lever, because of the time consumed by the engineman in getting into position and well braced before he can exert sufficient muscular force to throw the lever.

While the screw reverse gear is not new, but has been used extensively abroad for many years, the American Locomotive Co. states that its design embodies important changes from foreign practice. It provides a straight-line pull without offsets, and a screw inside of tubular connections and on the same longitudinal axis as the reach rod, thereby better adapting it to the greater weights of the valve-motion parts of American locomotives. By means of this straight pull, the gear and reach rod are not subjected to bending strains, but to tension or compression only.

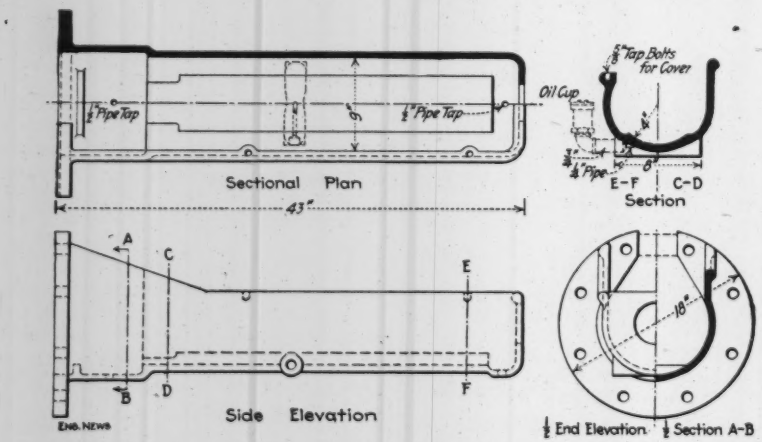

FIG. 7. SELF-CENTERING GUIDE FOR THE EXTENDED PISTON ROD. (BOLTED TO THE FRONT CYLINDER HEAD)

SELF-CENTERING VALVE-STEM AND PISTON-ROD GUIDES

Another important improvement in detail design introduced in this locomotive (and since applied extensively to others) is the use of self-centering guides for the valve stems and piston tail-rods or extension rods.

VALVE-STEM GUIDE—This is made integral with the back head of the valve chamber, and so constructed as to be easily adjusted for wear, as shown in Fig. 6. The chief advantage claimed for this arrangement is that it can be erected, taken down and replaced without any lining up, while at the same time insuring that the guide is absolutely in line with the valve chamber. This saves the time that is required for lining up the valve-stem guide of the ordinary construction (with the Walschaerts valve gear) when it is necessary to take down

TABLE I. DIMENSIONS OF EXPERIMENTAL PASSENGER LOCOMOTIVE (4:6:2 Class); AMERICAN LOCOMOTIVE CO.

Wheels; driving (6), diameter	6 ft. 7 in.
Front truck (4), diameter	3 ft. 0 in.
Rear truck (2), diameter	4 ft. 2½ in.
Trailer (8), diameter	3 ft. 0 in.
Front truck	Swing center
Rear truck	Radial; outside bearing
Journals, main driving axles	11 x12 in.
other driving axles	10½x12 in.
Wheelbase; driving	14 ft. 0 in.
Front truck	6 ft. 8 in.
Total engine	35 ft. 7 in.
Tender	20 ft. 10 in.
Driv. axle (1st) to truck axle	4 ft. 11 in.
Driv. axle (3d) to rear truck axle	10 ft. 0 in.
Wheels having blind tires	None
Weight in working order:	
On drivers (ave., 57,500 lb.)	172,500 lb.
On front truck	49,500 lb.
On rear truck	47,000 lb.
Engine, total	269,000 lb.
Tender, loaded	161,800 lb.
Cylinders (two)	27x28 in.
Crosshead and guides	Alligator; two-bar
Connecting-rod, c. to c.	9 ft. 8 in.
Valve gear	Walschaerts
Valves; piston, diameter	14 in.
Travel	6 in.
Power reversing gear	Screw
Boiler, type	Wagon-top
Diameter, 1st ring	6 ft. 3 in.
Plates, thickness, barrel	⅜ in. to ½ in.
Smokebox tube plate	½ in.
Center line above rail	9 ft. 11⅞ in.
Smokebox, length	6 ft. 1 in.
Superheater, type	Schmidt
Working pressure	185 lb.
Firebox; type	Wide; radial-stay
Size, inside	9 ft. 6 in. x 6 ft. 3 in.
Depth; front, 7 ft. 1⅞ in.; back	5 ft. 5½ in.
Crown, back and side plates	½ in.
Tube plate	½ in.
Crown stays (radial)	Wrought iron
Stay-bolts; ordinary (drilled), diam.	¾ in.
Flexible	Tate (471)
Firebrick arch	Security sectional
Water spaces; bottom width	4½ in.
Tubes; ordinary, 2¼-in	No. 207
Superheater, 5½ in	No. 36
Length over tube plates	22 ft.
Heating surface; tubes	3800 sq.ft.
Firebox	220 sq.ft.
Arch tubes	28 sq.ft.
Total	4048 sq.ft.
Superheating surface	897 sq.ft.
Grate area	59¾ sq.ft.
Exhaust nozzle, diameter	6¼, 6¼, 6¼ in.
Top below center of boiler	1 ft. 4½ in.
Smokestack, diameter	1 ft. 6 in.
Height of top above rail	14 ft. 7¼ in.
Water in tender tank	8000 gal.
Coal on tender	14 tons
Tractive power at 185 lb. working press	40,600 lb.

the valve motion. As this arrangement is self-centering, no bracing from the guides or any other source than the cylinder is required. It permits the use of a straight design of combination lever without forks, which is connected to the valve-stem crosshead by a pin passing through its wings, thus affording lateral stability.

PISTON-ROD GUIDE—The guide for the tail-rod or extended piston rod (Fig. 7) has a wide range of application, owing to the very general adoption of extension rods on locomotives equipped with superheaters. This device, like the valve-stem guide, is self-centering and can be removed and replaced in position without lining up, and at the same time exactly coincides with the longitudinal axis of the cylinder. A shoe is fitted to the extended end of the piston rod, being composed of a cast-steel body with a cast-iron wearing block secured to it by four bolts.

The shoe slides on a guide secured to the cylinder head, and the circular face of the guide registers with a corresponding face on the front cylinder head. This circular surface is struck from the center of the cylinder and the guide is so constructed that it can be cored out and faced off at one setting of the machine. The bearing surfaces of the shoe and guide are made radial so as to provide sufficient wearing surface to insure continuous service for two or three years without requiring adjustment of linings or repairs of any kind. Furthermore, the guide surface being concentric with the center of the cylinder, any refinement in adjustment between the shoe on the front of the rod and the main crosshead is unnecessary, since while the crosshead works on a flat guide, the piston-rod shoe will swing around on the center of the cylinder and thus always take a fair bearing without cramping. A dust-proof covering is provided, and the casing and guide are so constructed (the latter being of horseshoe form) that the guide can be removed without removing the pilot and bumper, whether the engine is on the front or back center.

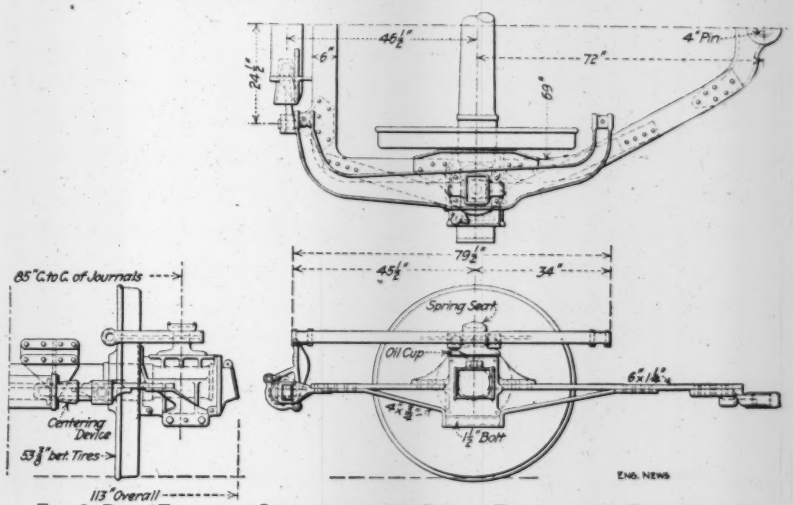

FIG. 8. REAR TRUCK OF OUTSIDE-BEARING RADIAL TYPE FOR THE EXPERIMENTAL LOCOMOTIVE OF THE AMERICAN LOCOMOTIVE CO.

TABLE II. COMPARISON OF THE BOILER OF THE EXPERIMENTAL LOCOMOTIVE (AMERICAN LOCOMOTIVE CO.) WITH THE BOILERS OF OTHER ENGINES OF THE SAME CLASS (4:6:2 PASSENGER)

	Experiment. Loco.	A	B	C	D
Weight of engine, total, lb	269,000	269,000	271,000	266,500	270,000
Boiler, type	Conical connection				Straight
diam. at front	76¾ in.	72 in.	72 in.	72 in.	79¼ in.
max. diam	87 in.	83 in.	83 in.	83 in.	83½ in.
Firebox, length	114 in.	108¼ in.	108¼ in.	108¼ in.	111 in.
width	75¼ in.	75½ in.	75½ in.	75½ in.	80½ in.
Tubes, No.	207	175	242	382	343
diameter	2¼ in.	2½ in.	2 in.	2 in.	2¼ in.
length	22 ft.	21½ ft.	21½ ft.	20 ft.	21 ft.
Superheater tubes, No.	36	32	28	....	....
diam.	5½ in.	5½ in.	5½ in.	....	....
Heating surf., sq.ft.	4048	3424	3784	4210	4427
Superheat. surf., sq.ft.	897	765	705	....	....
Grate area, sq.ft.	59.75	56.5	56.5	56.5	61.8

TABLE III. TABLE OF COMPARATIVE WEIGHTS OF CERTAIN PARTS OF THE EXPERIMENTAL LOCOMOTIVE AND ANOTHER OF THE SAME CLASS

	Experimental Locomotive Design and material	Weight, lb.	Similar Locomotive Design and material	Weight, lb.
Cylinders; with bushings, but exclus. of heads of cylinders and valve chambers	27x28 in. cast st., with c.i. bush	14,940	22x28 in. cast iron, bushed	17,600
Front bumper	Press. steel	575	Cast steel	1750
Pilot	Press steel	343	Wood	(est.) 700
Cross tie; front of firebox	Cast steel	715	Cast steel	1145
at drivers	Cast steel	665	Cast steel	485
Link supports	Bar steel	1014	Cast steel	1350
Link yoke	Bar steel	720	Bar steel	1058
Link yoke bracket	Cast steel	180	Cast steel	540
Bumper bracket	Cast steel	1150	Cast steel	1580
Equalizer fulcrum	Cast steel	554	Cast steel	1148
Trailing truck	New design	13,870	Old design	18,940
Total		34,726		46,296
Saving in above parts		12,570		

RADIAL REAR TRUCK

A saving in weight of 2500 to 3000 lb. was effected by the application of the builder's improved design of outside-bearing radial truck. The former type entailed the use of outside supplementary frames secured to the slab portion of the main frames by heavy cast-steel filling pieces. The new type of truck is now the builder's standard design for locomotives of the 4:6:2 and 2:8:2 classes. It provides for a universal adjustment of the

springs to the rise and fall of the engine, and a resistance to transverse motion through the combined action of the spring centering device and the inclined friction plates which operate to restore the truck to its normal central position on entering a tangent after passing a curve. As a result it greatly improves the riding qualities of the locomotive.

A modification in the structural features further improves the original design. This change consists in the use of a drop-forged sphere (made in halves riveted together) for supporting the spring seat, in place of the double trunnion arrangement originally employed. This new arrangement provides the same flexibility as before in the spring supports, whereby the easy riding qualities are secured, while at the same time it eliminates parts in the older construction which might be liable to cause lost motion and loose bolts. As all the spring seats are in compression, any wear and lost motion which may accumulate is taken up automatically, thus reducing the maintenance work on the truck.

A Comparison of Gas and Electric Power for Drawbridge Swinging*

The new steel swing span of the International Bridge over the ship canal at Black Rock, N. Y., which was erected in July, 1911, is one of the heaviest single-span bridges in the country, being 431 ft. 5 in. long, and weighing 4,500,000 lb. It carries a double track for steam trains besides a roadway for electric cars and pedestrian traffic.

The bridge is operated by electricity and can be swung in 70 seconds. Two Westinghouse street-car motors are used for turning the span, each rated at 53 hp. with ability to stand short overloads of 100%. There are two 15-hp. end-lift motors and two of 5 hp. for operating rail wedges. All are controlled from the operator's house above the bridge deck.

To supply current to these motors a small power station has been erected containing (1) a 100-hp. Otto gas engine direct-connected to a 60-kw. d.c. Garwood generator, (2) a 60-kw. Garwood motor-generator driven by a 2200-volt induction motor receiving current from a Niagara Falls power station, and (3) a 255-cell storage battery having a capacity of 60 amp. at the eight-hour discharge rate.

One of the yard men visits the station at certain periods and ascertains from the switchboard instruments whether or not it is necessary to recharge the storage batteries. Any desired combination of generators and storage battery may be made; all may feed the bridge motors, giving 400 hp. for a short time; one generator may be used for the bridge movements while the other is charging the battery. One man can easily start the gas engine.

Tests to find the power required for a day's operation were made on Sept. 3, 1911, with wind at a velocity of 4 miles per hour. The following data were secured, assuming ten 10-min. swings per day:

Navigation, house and deck lights, 17 lamps, 16 c.p., 12 hours per day	52.0 kw.-hr.
Signal lights, 16 lamps, 8 c.p.	1.7 " "
Rail wedges	2.2 " "
End lifts	0.7 " "
Air compressor (operating latch, whistle and band brakes)	3.8 " "
Turning motors	13.3 " "
Total	73.7 " "

Tests were made on Aug. 25, 1911, to find the cost of gas-engine power with a battery-charging load. The following data resulted:

Energy generated	108.4 kw.-hr.
Gas used	2608 cu.ft.
Length of run	3 hr.
Costs	
Labor, 30 c. per hr	$0.90
Oil, 40c. per gal	0.20
Water, 2c. per M cu.ft.	0.12
Gas, 30c. per M.	0.78
Total	$2.00
" per kw.-hr.	0.0184

With a charge-discharge efficiency of 65% for the storage battery and 10 swings per day, the cost of gas power to the bridge motors would be

$$\$0.184 \frac{73.7}{0.65} = \$2.09$$

For a year of 365 days the total cost would be

Interest, depreciation, repairs, etc., on gas-engine generating set (20%)	$1300.00
Power	764.00
	$2064.00

The cost of operation by Niagara Falls power was determined from tests made Aug. 31, 1911, with the motor-generator set charging the battery. The following data resulted:

Length of run	2 hr.
Output to battery	72 kw.-hr.
Input to motor	88 kw.-hr.
Efficiency of set	81.9%

The rate for Niagara power was given thus—at monthly rate:

Service charge	$50.00
Up to 1000 kw.-hr.	0.020
1000 to 2000 kw.-hr.	0.015
Over 2000 to 3000 kw.-hr.	0.012
Over 3000 to 4000 " "	0.010

With, as before, a demand on the motor of 113.5 kw.-hr. per day and a motor-generator efficiency of 81.9%, the monthly bill would be for

$$\frac{113.5 \times 30}{0.819} = 4160 \text{ kw.-hr.}$$

To find the resultant unit rate we take:

Service charge	$50.00
1000 to 2c.	20.00
1000 at 1.5c.	15.00
1000 at 1.2c.	12.00
1160 at 1c.	11.60
	$108.60
Per kw.-hr. input	2.6c.
Per kw.-hr. to battery	3.2c.

With a charge-discharge efficiency of 65% for the battery and 10 swings per day, the cost of Niagara power alone would be

$$\$0.032 \frac{73.7}{0.65} = \$3.63$$

For a year of 365 days the total cost would, then, be summarized thus:

Interest, depreciation, repairs, etc., on motor-generator set (15%)	$ 590
Power	1325
	$1915

According to this there is practically no difference in the total cost of operating the bridge by one service or the other. It should be understood that both services have been provided for continuity of operation and the expected annual costs are then combinations of the foregoing figures.

Expected Annual Cost with Gas Power

Interest, depreciation, repairs, etc., gas-engine set (20%)	$1300.00
Interest and depreciation on motor-generator set (7½%)	295.00
Power	764.00
Total	$2359.00

Expected Annual Cost with Niagara Power

Interest, depreciation, repairs, etc., on motor-generator set (15%)	$ 590.00
Interest and depreciation, gas-engine set (10%)	650.00
Power	1325.00
Total	$2565.00

*From results of tests made by R. D. Garner, Assistant Engineer Grand Trunk Ry., Buffalo, N. Y.; furnished by the Otto Gas Engine Works, Philadelphia.

Heat from the City Refuse of Minneapolis, Minn., is being utilized to generate electric current for 150 arc street lamps of 6.6 amperes each. The lamps have but recently been put in service. The city council has authorized the installation of 50 additional lamps. The health department, which collects the garbage and refuse and operates the incinerator, is paid $5 per lamp less than the city pays the lighting company. The Minneapolis incinerator is of the Decorie type. It was installed some years ago and heat from it has been used to light and heat the city workhouse, which is nearby. Garbage is drained by the householders of Minneapolis, wrapped in paper, and placed in covered cans. Combustible refuse from houses is collected with the garbage by the city once a week. Combustible trade refuse is brought to the furnace at private expense. Prior to beginning the street lighting service, an average of 45 lb. of coal per ton of garbage and other refuse burned was used, including coal consumed for light and heat when no refuse was being burned. The garbage is collected in steel wagon boxes of 4 cu.yd. capacity, hauled to a loading station and shipped by rail, 12 boxes per car, to the incinerator, which is in the extreme northern part of the city. To lessen the wagon haul, several additional shipping stations are proposed, this plan being considered preferable to scattering incinerators over the city. The foregoing statements are based on information given by Dr. P. M. Hall, Health Commissioner of Minneapolis. Dr. Hall states that draining and wrapping the garbage increases its combustible value per unit of weight besides helping keep the cans clean, decreasing the nuisance generally, and making once-a-week collection in the residence districts satisfactory, even in the summer time. Dr. Hall also states that there has been no serious difficulty in getting householders to wrap their garbage.

Small Vertical-Lift Drawbridges

Drawbridges may be divided generally into three classes: swing, bascule and vertical-lift. The two classes first named are the most widely known, but within recent years the third class has been introduced quite extensively. The Halsted St. 130-ft. lift bridge, built over the Chicago River in 1894, was one of the first notable structures of this class, but at the present time a number of important vertical-lift bridges are in operation and under construction. Some of these have been described in our columns.* Most of these bridges have been designed by Waddell & Harrington, consulting engineers, of Kansas City, Mo., who have given particular attention to developing this type of drawbridge under their patents.

One of the interesting features of the development of this type of drawbridge is its application to short spans (for both railways and highways) and to spans which require to be operated only occasionally, as where drainage dredges or a light amount of navigation have to be accommodated. The present article deals with two vertical-lift bridges of this smaller class, both of which are operated by hand. Both of them were designed by the firm mentioned above.

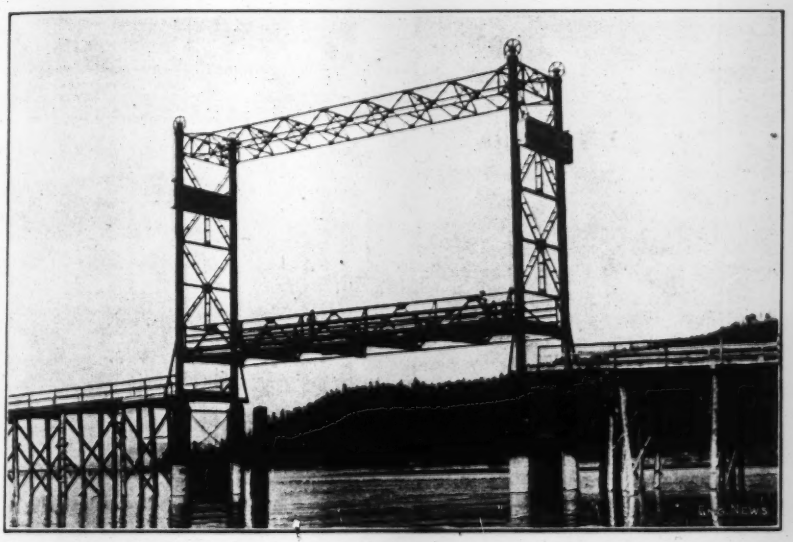

FIG. 1. VERTICAL-LIFT HIGHWAY DRAWBRIDGE AT SAND POINT, IDAHO

*Engineering News, Mar. 9 and Aug. 24, 1911.

SAND POINT BRIDGE

This is a vertical-lift truss span in a timber trestle two miles long, carrying a highway across the Pend d'Oreille Lake at Sand Point, Idaho. The lake is used for yachting, and the county authorities were required to provide an opening for navigation. The character of the lift bridge is shown in Fig. 1. The opening is 81 ft. 6 in. between piers, and the travel of the lift span is about 50 ft. This span consists of a pair of trusses 8 ft. deep, with 18-in. I-beams riveted into them and carrying wood joists 4x14 in., to which the 3-in. plank flooring is spiked. The clear width between wheel guards is 16 ft. The counterweight system is practically the same as in the Big Choctaw bridge, described below. The total weight of the span is about 58,000 lb. and the two counterweights weigh 29,000 lb. each. The substructure consists of four 48-in. cylinder piers 45 ft. high (35 ft. above the bed of the lake), with three 33-ft. piles to each pier, the piles penetrating to a depth of 25 ft. below the cylinder.

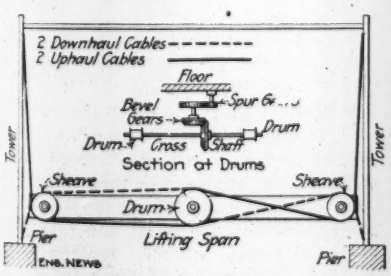

FIG. 2. DIAGRAM OF OPERATING MACHINERY; SAND POINT LIFT-BRIDGE

OPERATING MACHINERY

The machinery equipment is very simple, and is shown in diagram in Fig. 2. One man can raise or lower the bridge in three minutes. At the center of the span is a cross-shaft having on each end a drum long enough to provide for two uphaul and two down-haul cables, all the cables being ⅜ in. diameter. From each drum the cables are led to 12-in. deflecting sheaves at each end of the span, beyond which they are led to attachments at the top and bottom of the tower, as shown. The cross-shaft is driven through a pair of miter gears by a vertical shaft connected by a single set of spur gearing to a second vertical shaft, to the capstan head of which the operating lever is fitted when the bridge is to be moved. All of the gears are grouped so as to be carried in self-contained rigid boxes, bolted to one of the steel cross-beams. Thus there is no chance of slipping, and all meshing gears are assembled in the shop so that they cannot be put together incorrectly in the field. The operating gears comprise the following, all of 1 in. pitch and 2½ in. face:

	No. of teeth	Pitch diam.
2 bevel gears, each	30	9.55 in.
1 spur gear	68	21.65 in.
1 pinion	17	5.44 in.

The end locks are hooks which normally engage stops on the tower, but are drawn clear by means of wires attached to a loop handle, as shown in Fig. 3. On later designs for highway spans the locks are omitted entirely, a pawl on the operating shaft holding it in position so that the down-haul cables are kept taut when the span is down and so perform the function of the locks. For protection, chains are hung across the road when the bridge is to be operated, but when it is open the counterweights effectually block the roadway. This bridge was built in 1909, under the direction of John K. Ashley, County Surveyor (Bonner County). Its total cost complete was about $8300, including substructure, superstructure and machinery.

BIG CHOCTAW BAYOU BRIDGE; M. L. & T. R.R.

In crossing the Big Choctaw Bayou (in Louisiana), the Morgan's Louisiana & Texas R.R. was required to provide an opening for the accommodation of dredges and small vessels which occasionally use the channel. A vertical-lift span was adopted, and as the opening of the draw is required only at infrequent intervals it was considered sufficient to provide hand-power operating gear. The draw is a single-track plate-girder deck span of 50 ft., giving a clear width of 46 ft. between the piers. The rail level is

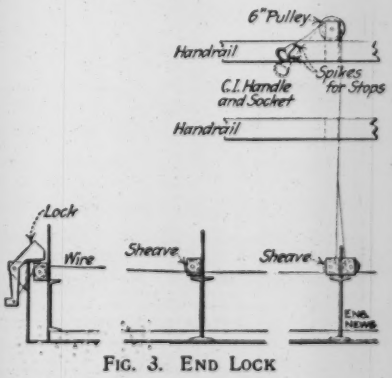

FIG. 3. END LOCK

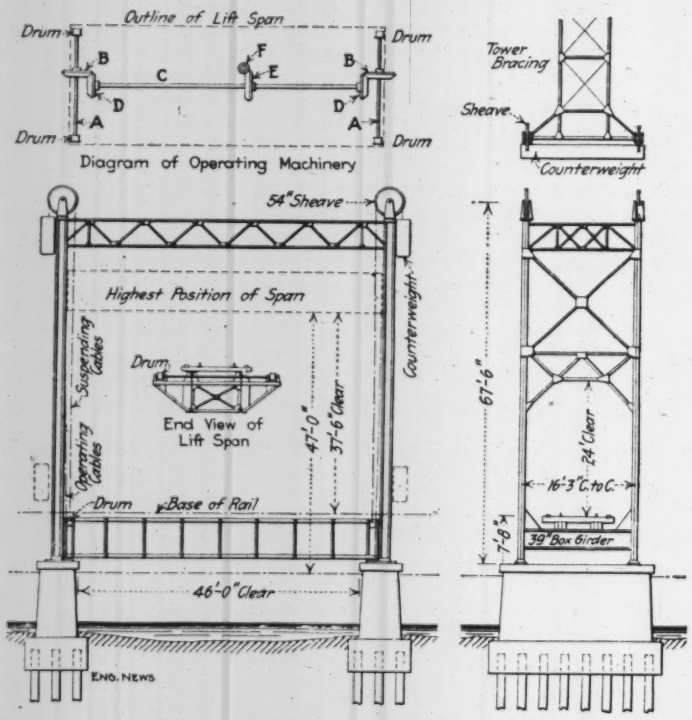

FIG. 4. PLAN AND ELEVATION OF VERTICAL-LIFT DRAWBRIDGE OVER BIG CHOCHTAW BAYOU; M. L. & T. R.R.

about 10 ft. above high-water level, giving a clearance of about 4 ft. below the girders, but with the bridge raised there is a clear opening of 47 ft. in height at high water. The approaches are short pile trestles. The two concrete piers have pile foundations and on each pier is a steel two-post braced tower, the towers being connected at the tops by lattice girder struts. The bridge was built in 1911, and cost approximately $15,000; of this amount, $7000 was for the substructure (including the temporary bridge and its operation), and $8000 for the superstructure and machinery. Fig. 4 shows the general design and construction.

LIFT SPAN—The 50-ft. lifting span is merely a simple plate-girder deck span having added to it a cross-frame at each end for the attachment of the cables, certain struts for machinery supports, and pins for the cable attachments. The construction is shown in Fig. 5. The girders are 6 ft. deep, with a dead load of 620 lb. per lin.ft. The ⅜-in. web plates extend ½ in. above the top chords, and the track ties are held in position by being notched to fit these plates. The web stiffeners are about 6 ft. apart. The bottom chord is composed of two 6x6-in. angles and cover plates. The top chord is composed of four angles 6x4 in. with side reinforcing plates. The girders are spaced 7 ft. apart. Sway bracing is provided at the second, fourth and sixth panel points, and at the fourth (middle) point there is also a transverse angle 6x8 in. between the top chords. There is the usual arrangement of top lateral bracing. At each end there is a cross-frame 18 ft. 9 in. long, carrying the drums for the operating cables, these drums being in line with the tower posts.

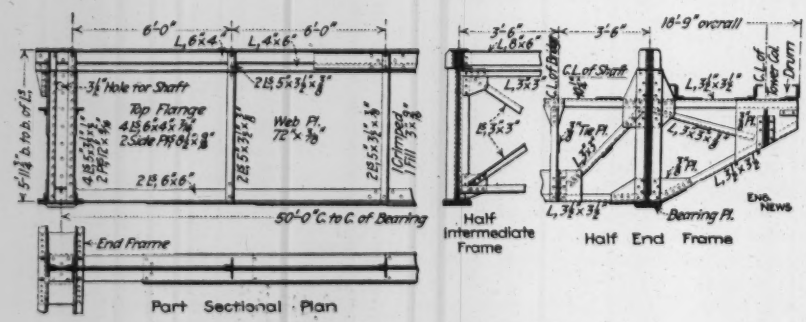

FIG. 5. DETAILS OF LIFTING SPAN

The approximate weight is as follow metal in span (except end frames), 30 500 lb.; floor, 26,000 lb.; end frames, m chinery, etc., 6100 lb.; total, 68,600 l

TOWERS—Each tower consists of tw columns 16 ft. 3 in. c. to c., with a heigh of 67 ft. 6 in. from the masonry to th shafts of the counterweight sheaves. Th columns are of H-section, composed of a web plate ⅜x17½ in. (parallel with th bridge) and four Z-bars 6x3½ in.; on each of the two outer flanges is an angle 3x2 in., forming a guide for the counterweights, and on each inner flange is a plate ½x3½ in. Portal and top bracing are provided as shown. Near the bottom is a floor-beam consisting of a 39-in. box girder, having the webs 17 in. apart and fitting inside the Z-bars of the columns; the ends of the web plates form gusset connections with the columns. The webs are of ⅜-in. plate, with a bottom chord

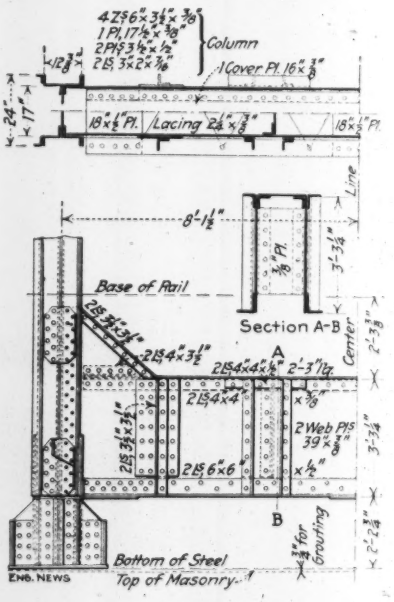

FIG. 6. DETAILS OF TOWERS FOR LIFT BRIDGE

composed of two outside angles 6x6 in. and top chord composed of two inside angles 4x4 in. with a cover plate. Transverse diaphragms are fitted between the webs. Fig. 6 shows the details of the tower design.

The top longitudinal strut between the towers consists of a pair of lattice girders 4½ ft. deep, placed 8 ft. apart. They are connected by cross-frames and 1-in. diagonal rods, while horizontal diagonal braces at the ends extend from the girders to the sides of the towers. A steel ladder is built on one tower, and a plank walk extends along the top strut to give access to the counterweight sheaves, for purposes of oiling or inspection. In regard to wind load on the structure, the worst condition occurs

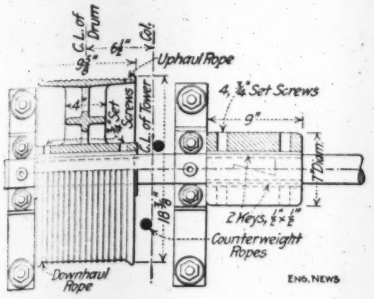

FIG. 7. DRUM AND CABLE ARRANGEMENT

when the span is down. The exposed areas for wind load and the wind loads for each tower are given in the accompanying table.

12 laps and the down-haul cable 1½ laps around the drum. As the drum is revolved, one cable is wound upon it and the other is paid out. The drum is shown in Fig. 7, and the arrangement of the machinery is shown in Fig. 1.

The two drums at each end of the bridge are mounted upon a single cross-shaft *A*, which carries a bevel spur wheel *B*; a longitudinal shaft *C* carries at each end a bevel pinion *D*, thus driving both cross-shafts. A bevel gear *E* on the shaft *C* meshes with a pinion *F* on a vertical shaft, which is fitted with a capstan head. The three pairs of bevel gears are identical, so that only one pattern of spur wheel and one of pinion is required. The pitch is 1 in. and the width of face 2 in. The spur wheel is

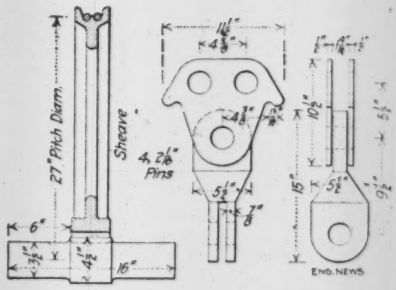

FIG. 8. SHEAVES FOR COUNTERWEIGHT CABLES AND EQUALIZERS FOR ATTACHING THE CABLES TO THE LIFT SPAN

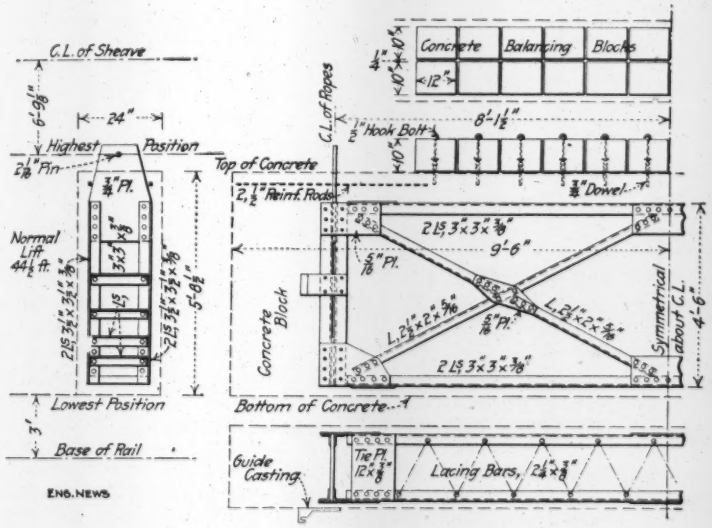

FIG. 9. COUNTERWEIGHT FOR LIFT SPAN.

WIND LOADS ON 47-FT. LIFT BRIDGE

	Exposed area sq.ft.	Wind loads on one girder: Span up 15 lb. per sq.ft. lb.	Span down 50 lb. per sq.ft. lb.
Girder and floor	384	2880	
Overhead bracing	88	660	2200
Sheaves (2)	16	240	80
Counterweight	13	....	650
Columns (2); per ver. ft. of tower	4	60	200

OPERATING MACHINERY

One of the specially interesting features is the hand-power operating machinery, which is different from that of the Sand Point bridge. At each corner of the lifting span is an 18-in. spirally grooved drum carrying two ½-in. wire cables; each cable has one end attached to the drum, while the other end of the up-haul cable is attached to an anchor at the top of the tower column, and that of the down-haul cable is similarly attached near the bottom of the column. The arrangement is such that when the bridge is down, the up-haul cable has 16.87 in. diameter with 53 teeth, and the pinion is 6.86 in. diameter with 21 teeth. The operating lever is a piece of 2½-in. wrought-iron pipe bent to shape, and having welded to its lower end a forged-steel head which fits upon the 4-in. capstan-head of the vertical shaft. The capstan head is just below the floor, and a platform is spiked to the ties for the accommodation of the operator. The bridge can be raised or lowered in 10 minutes. All gears are of cast steel, with 20° involute machine-cut teeth. They are keyed to steel shafts which are carried by cast-steel bearings fitted with bronze bushings.

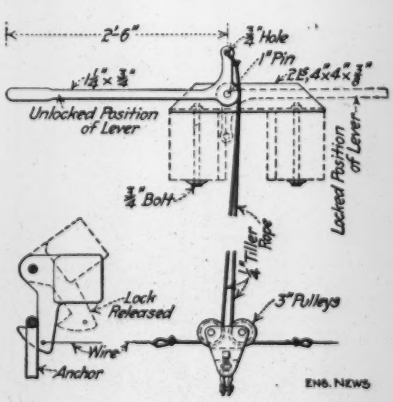

FIG. 10. END LOCK FOR LIFT SPAN

COUNTERWEIGHTS—At each end of the bridge is a counterweight (Fig. 8) suspended at the rear of the tower by two pair of 1-in. cables which pass over sheaves of 54-in. pitch diameter on top of the tower and are attached to equalizers carried by pins in the girders (Fig. 9). The counterweight is a lattice-work steel box embedded in concrete forming a block 19 ft. long and 68½x24 in. section. The weight of concrete is taken as 145 lb. per cu.ft., and the counterweight weighs about 32,700 lb. (of which the steel represents 1800 lb.) The weight to be lifted is 33,725 lb. for each counterweight. The actual weight of the counterweight is adjusted by means of concrete balancing blocks 12x10x10 in.; each block has a bottom hole fitting a ¼-in. dowel (which holds it in place), and has a ½-in. hook bolt on the top.

END LOCKS AND RAIL CONNECTIONS—At each end of the lift span is a lock consisting of a hook which turns on a pin and engages with a lug on the tower. To release the span, these are withdrawn simultaneously by means of wires which are attached to the locks and to a bell-crank lever on the floor of the span, one arm of the lever forming the operating handle. When the bridge is lowered, the locks engage automatically with the fixed lugs. The lock is shown in Fig. 10. As the span lifts vertically, the rail joints required are merely scarfed rails which slide together as the span seats itself. Usually a hole through the two parts permits a bolt to be shot by the signal operator, or in connection with home and distant semaphore signals. We are not advised what signal system has been installed for this bridge span.

Northern Pacific Ry. Station, Tacoma

Among the many improvements carried out by the Northern Pacific Ry. at its Pacific coast terminals is the construction of a new passenger station at Tacoma, Wash. The new station is on the east side of Pacific Ave., where the tracks (parallel with the street) are 27 ft. below the street level and at a sufficient distance from it to permit of placing the station between them and the street. The building has one story on the street side, but has two lower floors beneath the main floor (at the street level). The architects were Reed & Stem, of St. Paul, Minn., and we are indebted to them for plans, photographs and other information. W. L. Darling is Chief Engineer of the railway. Fig. 1 is a view of the Pacific Ave. front of the station.

The construction of elaborate passenger stations in the large cities today forms no small part of the expenses of a railroad. It is debatable whether these stations, particularly those of the very expensive type, such as have recently been completed in Washington, Baltimore, New York and Chicago, are justified by the returns upon the investment, but it is nevertheless the fact that the railways are contributing much to the "city beautiful" idea. The station described below is another of the same class.

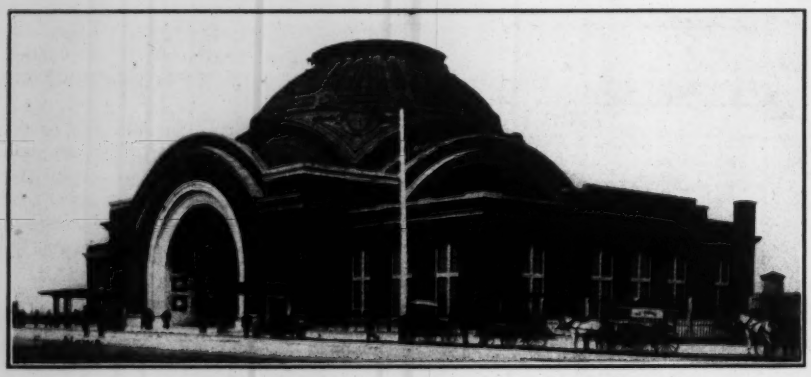

FIG. 1. NEW STATION AT TACOMA, WASH.; NORTHERN PACIFIC RY.
(Reed & Stem, St. Paul, Minn.; Architects.)

The passenger terminal and station are used also by the Oregon-Washington Ry. & Navigation Co., under agreement with the Northern Pacific Ry. Co.

STATION BUILDING

The building is about 200x120 ft., with 200-ft. frontage, and consists of a rectangular central portion flanked by two wings. This central portion is surmounted by a steel-framed dome, which is one of the architectural features of the structure and rises to a height of 100 ft. above the street. Short barrel roofs extend from the base of the dome to the four sides of the building. The main entrance is through an archway 42 ft. wide, the screen at the back of which has ten doors opening into a vestibule. At each side of the arch is a smaller passage, and these have steel-framed canopies or shelters extending across the sidewalk, but there is no canopy to interfere with the appearance of the great central archway. A section through the station and a plan of the main (upper) floor are given in Figs. 2 and 3. The structural work is mainly of steel and concrete. The exterior walls are of dark red paving brick and light Bedford stone, the brickwork being pointed with black mortar. The interior walls are faced largely with marble, and the floors are of terraza, with borders of marble and mosaic. The decorative work is very elaborate.

The main waiting room is at the center of the building, directly under the dome, and has a vaulted ceiling carried by a steel frame beneath the dome. This ceiling is of stucco, deeply paneled, as shown in Figs. 2 and 4, and rises above four large arched openings, as shown. The center of this ceiling, about 65 ft. above the floor, is crowned by an open eyelet admitting light from a shaft which extends up to a skylight in the summit of the dome. The main framing of the dome (Fig. 5) consists of steel trusses arranged diametrically and connected by latticed struts which support the ribs or rafters of 6-in. and 7-in. curved channels. One of the trusses is shown in Fig. 6, together with the hangers and framing for the vaulted ceiling. One end of each truss is provided with a roller-shoe bearing. The dome is covered with copper, over a sheathing of 2-in. plank.

The main floor is at the street level, and its plan is shown in Fig. 3. In the center is the large main waiting room with its vaulted ceiling, described above, and shown in Fig. 4. This room is flanked by the ticket office, telegraph office, parcel room, information bureau, news stand, etc. The two wings contain the dining, smoking, toilet and women's rooms; also the main baggage room and checking counter. A mezzanine floor, with balconies carried beneath the arches of the waiting room, affords a quiet resting place and a retreat from the activities and traffic of the main floor. Four broad stairways at the corners of the central space connect the main floor with the concourse floor below. Two of these lead directly from the waiting room, and

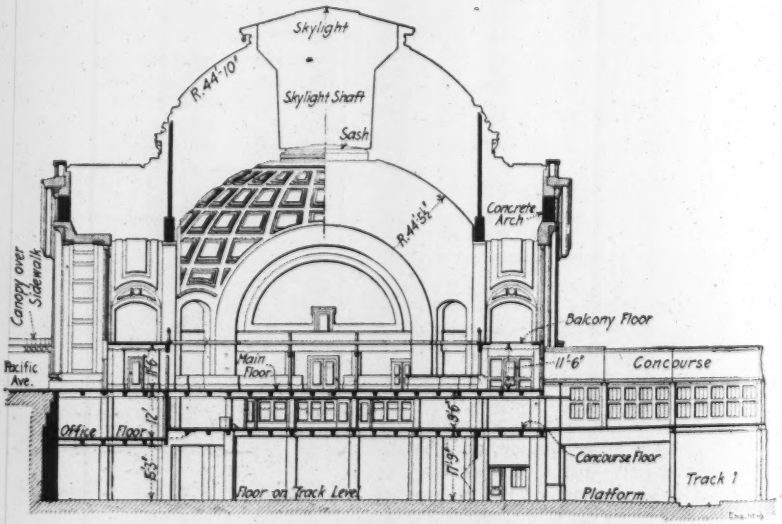

FIG. 2. CROSS-SECTION THROUGH STATION

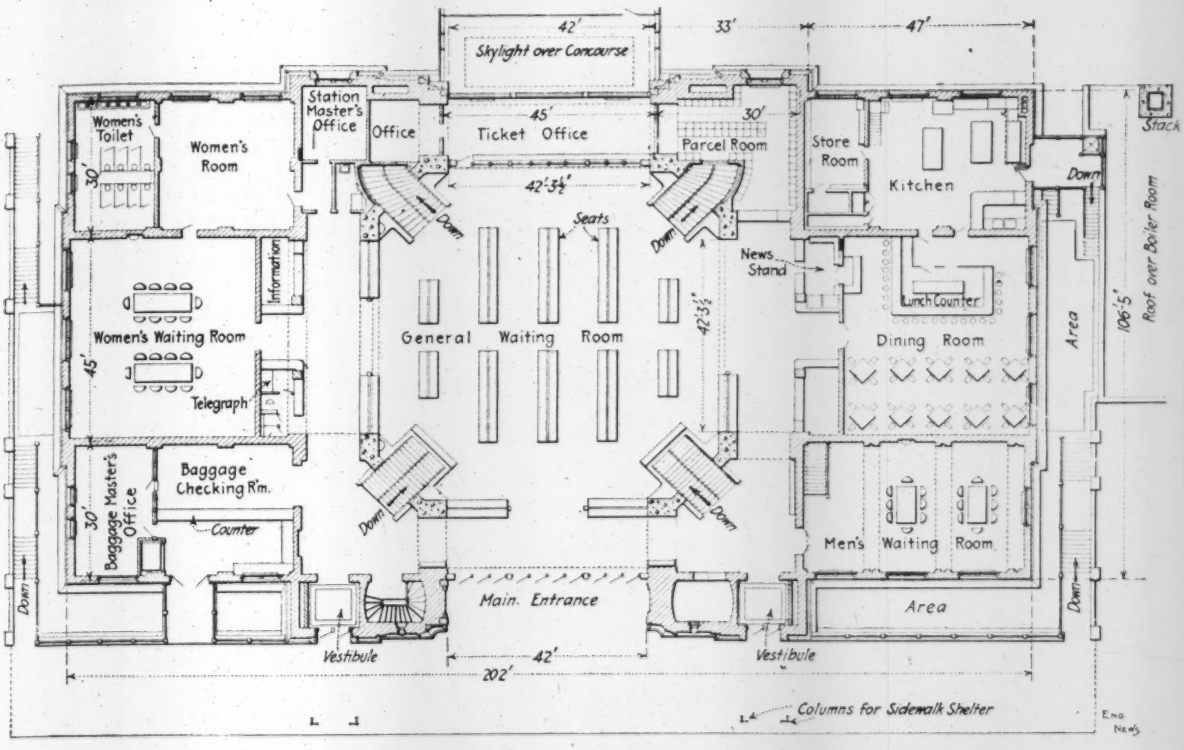

FIG. 3. PLAN OF MAIN FLOOR AT STATION AT TACOMA, WASH.

two from points near the entrance. The details of these stairs are shown in Fig. 7.

An extension of the concourse floor is carried by a bridge spanning the platforms and tracks; this is entirely inclosed and forms practically an auxiliary to the waiting room. At each platform there is a lateral extension of this concourse, leading to an elevator and stairway. Passengers going to the trains enter from the street, and after getting their tickets and checking their baggage they descend the stairs to the concourse, from which they descend to the platforms as directed by the ticket inspectors. Passengers from the trains go up to the concourse and pass out through the building. It will be noted that the two stairways near the front of the building enable passengers to go directly to and from the concourse without passing through the waiting room.

The lower or basement floor of the building is utilized for mail, express and baggage. An elevator connects the upper and lower baggage rooms, and a pneumatic-tube system provides for the transfer of baggage checks, etc. Passengers do all their checking on the upper floor, the lower one being for handling and storing baggage. An inclined roadway at the north end of the building enables baggage, mail and express wagons to have access to the lower floor and the main platform. At the southeast corner of the building (at the track level) is a one-story extension about 40x70 ft., for the power house; this bas a boiler room, fuel space (oil) and engine room for the lighting and heating plant and the vacuum-cleaning system.

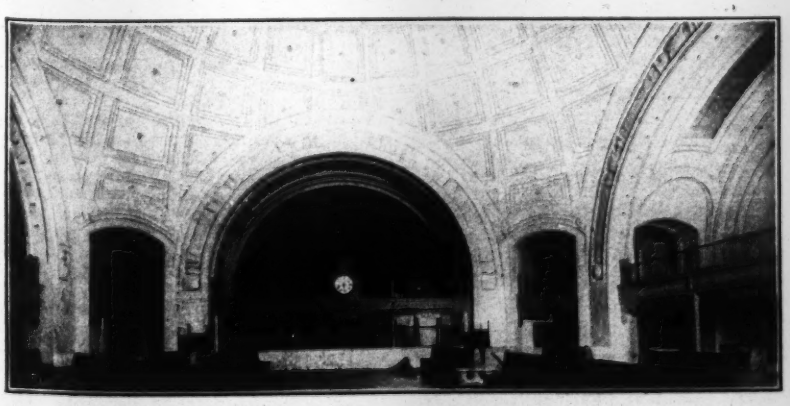

FIG. 4. INTERIOR OF MAIN WAITING ROOM

PLATFORMS AND TRACKS

The platforms and tracks are shown in Fig. 8. At the track level a broad asphalt-paved platform extends in front of the building to a single track. Beyond this are two island platforms of concrete, separated by a pair of tracks (14 ft. c. to c.), while a fourth track is on the far side of the second island platform. The width across platform from c. to c. of tracks is 30 ft. From the first or inner track is run a spur track extending along the back of the platform as far as the power house; this provides for cars handling coal and ashes, and also for mail and express cars. The main platform is covered only in front of the station building; the central part of its roof is carried by trusses built into the wall and supported near the outer end by columns which are kept 10 ft. back from the edge of the platform so as to afford no obstruction to the movements of passengers at the trains. On either side of

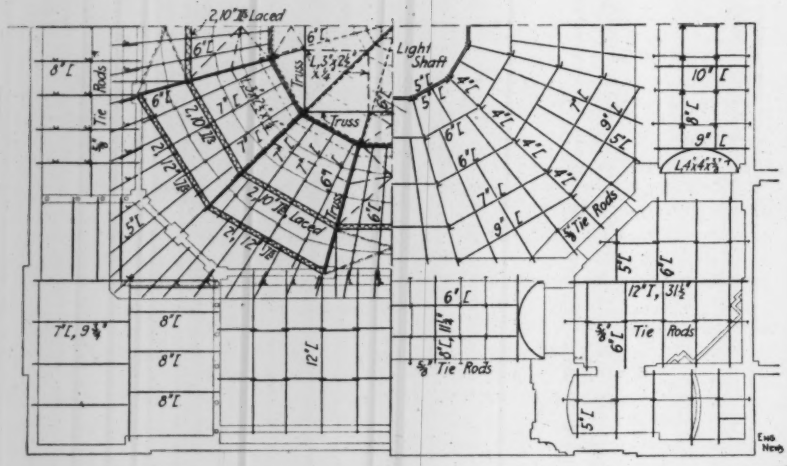

FIG. 5. PLAN OF FRAMING OF DOME AND VAULTED CEILING

this is a shelter roof extending along the front of the platform. Each of the two island platforms has a shelter roof of the butterfly type, the roof sloping down from the sides to a central drain. The roofs is supported by lattice cantilever trusses on a center row of columns, spaced 20 ft. apart. Each column is composed of a pair of channels set back to back and about 1⅛ in. apart. Fig. 9 shows the wide roof or marquee on the main platform, and also the construction of the platform shelter roof.

The Longest Continuous Railway Run in Germany, 195 miles, is from Nuremberg to Halle, on which line a no-stop train was put on June 1, 1912, as part of the Munich-Berlin run. The other portions of the Munich-Berlin route (from Munich to Nuremberg, 124 mi., and Halle to Berlin, 101 mi.) have already been no-stop runs for the same through train, so that at the present time the distance from Munich to Berlin, 420 miles, is covered with only two station stops, Nuremberg and Halle. The Nuremberg-Halle run, while about 20 miles longer than the longest previous no-stop run in Germany, is only technically a no-stop run, as pushers are taken on to mount a heavy grade at one section of the run. The average speed of this train between Nuremberg and Halle (4 hr. 33 min.) is only 43 miles per hour, on account of the pusher grade. The next longest no-stop run, Berlin to Hamburg, 178 miles, is made in 3 hr. and 14 min., an average speed of 55 miles per hour.

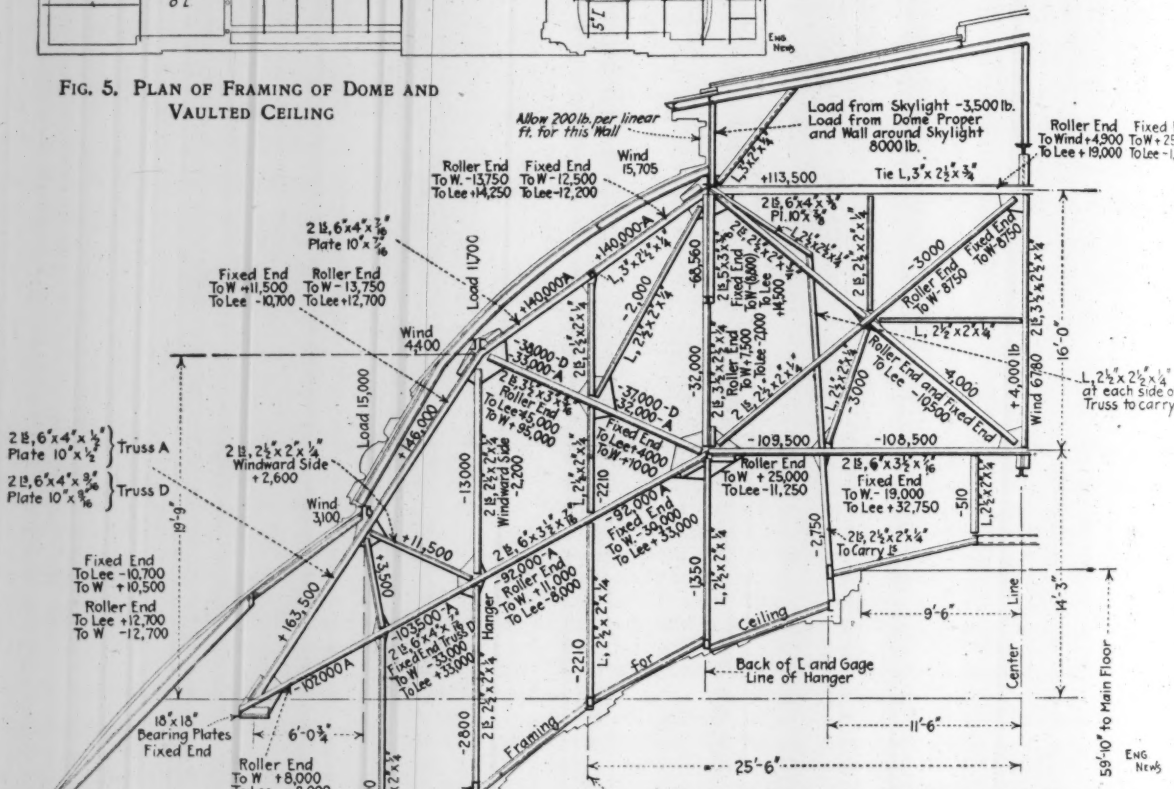
Load from Skylight -3,500 lb.
Load from Dome Proper and Wall around Skylight 8000 lb.
Allow 200 lb. per linear ft. for this Wall
Roller End To Wind +4,900 To Lee +19,000
Fixed End To W +25,500 To Lee -1,750
Tie L,3" x 2½" x ¾"
Roller End To W. -13,750 To Lee +14,250
Fixed End To W -12,500 To Lee -12,200
Wind 15,705
Load 11,700
Fixed End To W +11,500 To Lee -10,700
Roller End To W -13,750 To Lee +12,700
Wind 4400
Load 15,000
Truss A
Truss D
Windward Side +2,600
Wind 3,100
Fixed End To Lee -10,700 To W +10,500
Roller End To Lee +12,700 To W -12,700
Roller End To W +8,000 To Lee -8,000
18"x18" Bearing Plates Fixed End
Gusset Connections at Hanger
Back of L and Gage Line of Hanger
44'-10⅝" to C.L.
37'-5" to C.L.
Roller End To Wind +4,000 To Lee +10,500
Fixed End To W +8,750
Roller End To W -8,750
Fixed End To W +25,000 To Lee -11,250
Fixed End To W -19,000 To Lee +32,750
Roller End To Lee -10,500 and Fixed End
Wind 6780
+4,000 lb
Ceiling
Back of L and Gage Line of Hanger
9'-6" Line
11'-6"
25'-6"
14'-3"
59'-10" to Main Floor
Center
For
Framing
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FIG. 6. HALF ELEVATION OF TRUSS FOR DOME

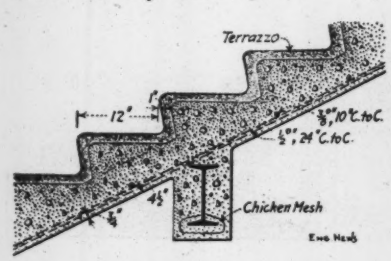


FIG. 7. REINFORCED-CONCRETE STAIRS

Casting Pure Copper by the Use of Boron Suboxide*

By R. D. Thomson†

Along with the development of electrical machinery and apparatus there has been a great demand for mechanically sound, high-conductivity cast copper. A vast amount of effort has been expended in the search for some process by which castings could be made which would compare favorably with forged copper. Many compounds have been on the market and many foundrymen claim to have secret processes for accomplishing the desired result, but in no case has the result, if satisfactory, been commercially practicable. Some eight years ago it was found that sound castings could be made in metal molds, using "poled" copper of tough pitch, such as is used in wire making; but the method was not practicable because of the cost of the molds, and because the casting had to be done in a refinery and not in a foundry.

For years progress had been away from the use of cast copper, and this in itself added an obstacle to the production of this copper. In spite of the failures and discouraging results of others, Dr. E. Weintraub, of Lynn, Mass., finally succeeded in producing the long-sought-for substance by the addition of boron suboxide to molten copper. It is now a simple matter to cast sound, high-conductivity copper in either sand or metal molds. In the short space of two years, the process has come into extensive use in the foundries of electrical manufacturers and elsewhere.

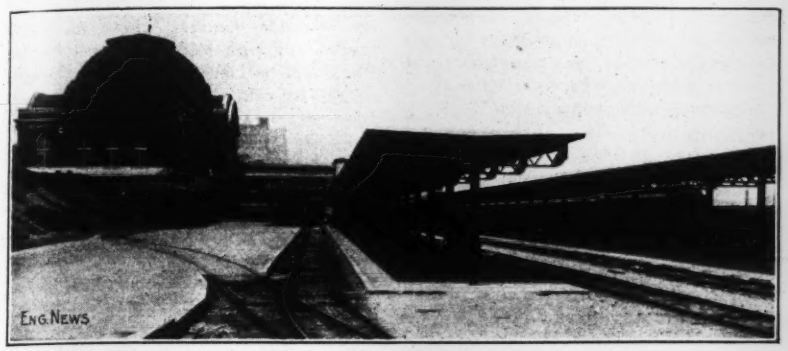


FIG. 8. TRACK LEVEL OF NEW STATION AT TACOMA, WASH.; NORTHERN PACIFIC RY.

In order to get high conductivity when using boron suboxide, it is essential to start with pure copper, as the compound is not a purifier but simply a deoxidizer. If impure copper is used the casting will be sound, but the conductivity will be reduced in proportion to the amount and kind of impurity present. The copper is heated to a temperature approaching 1350 deg. F. and the suboxide added, the reaction taking place immediately. At lower temperatures the reaction takes place slowly and there is danger that the copper will cool down too much to cast before the reaction is completed. Best results are obtained by the use of 1 per cent. by weight of the compound added to the copper; that is, 1 lb. for every 100 lb. of metal melted, although the amount may be somewhat diminished or increased without perceptibly changing the action. This gives us a process, therefore, which can be handled by any foundryman and which will always give the desired result.

Castings made in this way are mechanically sound throughout, being entirely free from blow-holes, and can be readily machined. Electrical conductivity as high as 97% has been obtained, while in general practice it is found to be 88-90%. Many shapes and sizes are being made at present with no more difficulty than in the case of brass, while some other castings are being made which cannot be made in brass, because of the difficulty in getting homogeneity. Among the simple parts are to be found conductors, terminals, collector rings, contact blades, etc., etc. In many cases a saving is being effected through the reduction in bulk made possible by the increase in conductivity, especially where high mechanical strength is not essential.

The advantages gained by the use of pure cast copper are not limited to the qualities of high electrical conductivity and mechanical soundness. It is capable of taking very complicated molds, making it possible to use castings where formerly the pieces were built up. A blowout coil formerly built up from bar copper wound to form, the terminal pieces being riveted and soldered in place, can be easily cast in one piece in a sand mold, using the deoxidized copper. The helical turns of the coil are squeezed together after casting. Now this process is used entirely in the manufacture of these coils, replacing those built of several parts, with considerable saving of time and cost.

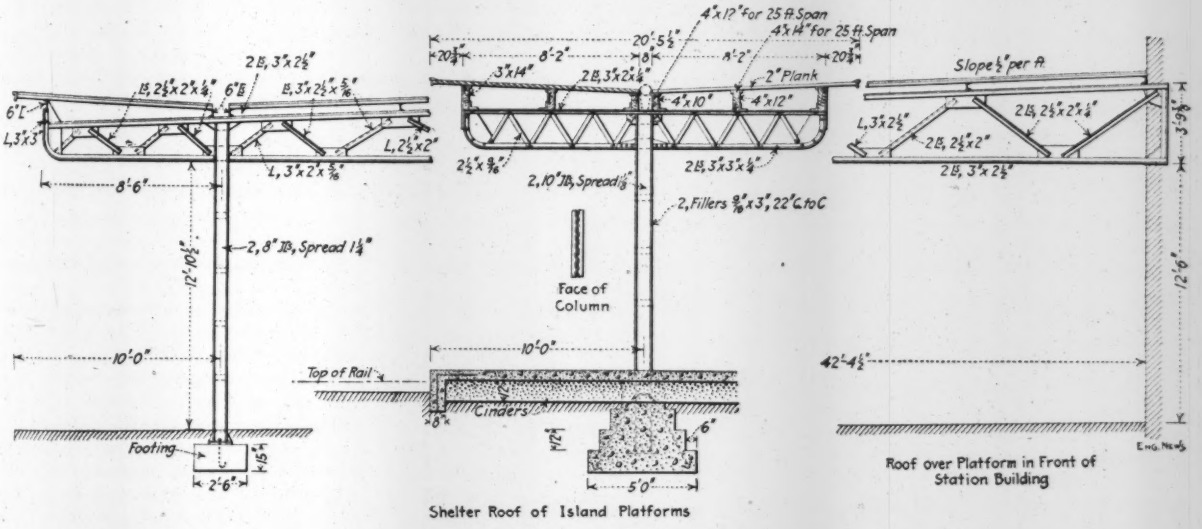


FIG. 9. PLATFORM SHELTERS

*From the "General Electric Review."

†Supply Department, General Electric Co.

Shopwork for Engineering Students

By Winslow H. Herschel *

How shall the student of mechanical engineering gain the practical experience in manufacturing methods, tools and customs, without which he cannot become in any sense a mechanical engineer? The author considers the college shop and its defects and proposed substitutes. He concludes that the German system, under which the student must have had at least a year of practical shop work before receiving his degree at graduation, is superior to any other.

*Assistant Professor of Mechanical Engineering, University of Maine, Orono, Me.

The usual plan in the United States is for each technical school to have its own college shop, not for commercial purposes, but merely for the instruction of students. This shopwork is not for cultural purposes, as in a manual-training school, nor primarily to develop manual skill, as in a trade school. To quote the words of Prof. D. S. Kimball, of Cornell, who speaks from experience with one of the best college shops in the country, "The purpose of shopwork in an engineering college should be to instruct the student in shop methods and processes; and next to this, to give him as much manual development as time will permit."

The college shop may be regarded as a natural reaction from the earlier neglect of technical education. Until a comparatively recent date, both in England and America, almost all young men who desired a technical training entered a machine shop or the office of a civil engineer at the age of 15 or 16, and after a period of five years or so, including one or two years' shopwork, their education was considered as finished. From assuming that technical schools were unnecessary, educators went to the other extreme and assumed that the schools could and should give all the necessary training. Now, having tried this latter method long enough to judge fairly of the results, we find a nearly unanimous opinion that technical training should be made more "practical."

The late R. T. Crane, of Chicago, a bitter critic of all educational methods in vogue, advocated the almost complete elimination of technical schools, and the substitution of training in a commercial shop. Mr. Crane carried to an extreme the lack of appreciation of theoretical studies and scientifically trained engineers which is unfortunately very prevalent among Americans, yet there is considerable justification for his point of view. He was by no means alone in the opinion that our technical schools have failed to produce the kind of men desired by employers. In fact, Frederick W. Taylor, Past-President of the American Society of Mechanical Engineers, expresses the opinion that Mr. Crane voiced the view of the great majority of the employers of this country. That Mr. Taylor himself agrees with them is evident from his saying that some ten years ago he made up his mind never to employ a college man until he had been at least two years out of college, with an exception only in the case of those who had had experience in a commercial shop before graduation.

Various attempts have been made to improve technical education so as to make it more practical, the methods adopted being of two kinds, those which aim to make conditions of work in a college shop more like commercial conditions, by using apparatus of commercial size, introducing strict discipline, etc., and those which give up the college shop and require the student to get his training in shopwork in a commercial shop.

The first method has been carried to its highest development at the Worcester Polytechnic Institute, where a shop, operated by the Institute, manufactures machinery for sale, and it is said to have been self-supporting. Apart from other objections, this method appears to be of value only in occasional instances where a school happens to be located near an industrial center where manufacturing could be carried on without too great a loss. Even under the most favorable circumstances it is doubtful whether suitable instructors could be found. A modern factory is a vast manufacturing machine, requiring executives skilled in transportation, works design, stores keeping, wage systems, shop management and cost analysis. The field is too large to be well cultivated with the facilities available. Those qualified to teach theory can hardly be expected to give uptodate, practical instructions in the applications of theory to manufacturing, and the graduate who comes to a factory with crude ideas which have to be unlearned, is hindered rather than helped by his "practical" training.

The second method of improving technical education has been adopted by several large companies, including the General Electric Co., the Westinghouse companies, and the Allis-Chalmers Co. They have established what are known as "student courses" where they receive graduates from technical schools and give them such training, mainly in assembling and testing, as will make them future valuable employees. This solution of the difficulty is not available for many mechanical engineers, because there are very few such courses open to them. Many firms which are sometimes said to have "student courses," have in reality merely apprenticeship systems which should not be confused with post-graduate student courses. Furthermore, on account of the small amount of testing necessary in mechanical engineering, as compared with electrical engineering, it would not be practicable for many employers to establish such student courses.

The University of Cincinnati has a plan in operation, under which electrical, chemical and mechanical engineering students obtain experience in a commercial shop during the same years as their college work, instead of after graduation, as with the General Electric Co.'s system. The course extends over six years, during which the students work alternate weeks in the shops of the city throughout the scholastic year, and full time in summer. Since each class is divided into two sections, one of which is at the shops while the other is at the university, the employer always has the same number of student employees, and is not inconvenienced by the alternations of any group of students between the shop and the university.

Somewhat similar to this plan is the so called "Sandwich" system of Great Britain, which, however, attempts to teach theory to apprentices, rather than practical knowledge to technical students. As established in 1903 at the Sunderland Technical College, for example, this apprentice-studentship plan provides that each year a limited number (not more than 25) of free apprentice-studentships shall be offered for competition among apprentices employed by shipbuilders and engineers of the neighborhood, who are under 18 years of age, have served creditably not less than two years in the shops and attended certain evening classes during this time. During the three or four years following their selection, the successful apprentices are allowed leave of absence from Oct. 1 to Mar. 31 of each year to attend the day classes of the technical college. The time spent in the college is reckoned as part of the apprenticeship, so that the rate of advance of wages is the same as for those who work continuously in the shop. During the summer months special facilities are given the student apprentices, as far as possible, for traversing all departments of the works.

The "Sandwich" system is less desirathan the Cincinnati plan, because, for half the year, employers are deprived of part of their employees; and it is only applicable where, as at the Sunderland

Technical College, the work at the school lasts only half the year. In general it may be said, in regard to all systems involving work in a commercial shop and at a technical school during the same year, that they can be applied with success only under specially favorable circumstances, and that therefore they do not furnish a general solution of the difficulty. There is also a question whether, with the best instructors obtainable, a student could derive the same benefits from them as from ordinary commercial work.

Engineering, perhaps, requires a greater amount of physical energy than any other learned profession, and a boy who is not strong enough to do shopwork had better give up the intention of becoming an engineer. He needs not only strength of body, but strength of will and moral courage; he needs candor, imagination, large vision, high ambition and many other attributes of character which ordinarily do not receive sufficient attention in his education. Col. H. G. Prout, who for many years edited the *Railroad Gazette*, returning afterward to active professional practice, came to the conclusion, from the observation of engineering works employing about 20,000 men, that "engineers reach the limit of their usefulness from defects of character, rather than from want of technical attainments."

There has indeed been some improvement of late in methods of mental training. It has gradually become recognized that the mere remembrance of facts is of comparatively little value. It is ability which counts, ability such as is tested by original problems in geometry and by translations at sight. The movement for vocational guidance is excellent and timely, and will save many from picking out their life work, or having it decided for them for trivial reasons.

But this is not enough. The student should have a motive or desire for learning, and an intelligent appreciation of the privilege of studying. There is need, by some means or other, of leading a student to a wise selection of studies, or where the work is prescribed, to an understanding of the reasons for their being in the curriculum. He has no idea how or why a curriculum is made up. No one gives him even an elementary knowledge of pedagogy sufficient to enable him to take an intelligent interest in his own education. No one, unless it be the commencement-day speaker, tries to impart such fundamental ideas of the relation between the different branches of learning as will enable him to appreciate the value of each. He ought to be made to realize that engineering books cannot be understood without a knowledge of mathematics; that a knowledge of modern languages opens the door to a vast technical literature from which he must otherwise be excluded; that to successfully work in an applied science like engineering, one must have a knowledge of the pure sciences upon which engineering depends.

On account of lack of familiarity with such ideas as these, students, as a rule, have a deplorably low appreciation of scholarship. In the preparatory school the only motive for study is to be able to pass the college entrance examinations; in college the one idea is to get enough credits to graduate. Graduation the student believes in some vague way to be desirable, but he regards the separate courses that lead to graduation as something to get through with the least expense of time and energy. When a student has passed the final examination in a course, he is too apt to think that is the last he will have to hear of that subject, and to have little thought that the knowledge acquired in one course must be applied in subsequent courses and afterward all through life.

It is not my intention to blame the average student. It is not his fault but his misfortune that no one during all the years of his school life, with rare exceptions, has taken much trouble to point out the value of knowledge in general or of any study in particular; to dwell on the reasons for going to college, or for making the most of one's opportunities while there.

It is possible that something might be gained by prescribing courses in methods of education, but I doubt whether much could be accomplished by this method. Just as a doctor's bread pill would lose its value if the patient should learn its true nature, so might educational methods become much less effective if students should learn too much about the machinery of education.

But let a student enter a commercial shop, let him work as a workman side by side with the regular employees, and he will get a new point of view in regard to life and work. First of all he will find to his surprise that an uneducated man is not always stupid, that the man next to him at the bench may be far more intelligent than he is. He will realize what sort of a life is in store for an uneducated man, and see that the only way for him to fare better is by getting the best education he can. This will give him a spirit of ambition to attack his college studies with an eagerness not always now observable.

Most students have little idea what a day's work really is. They do not realize that, as a rule, work is more or less of a dull, monotonous grind, and that most of the work of every man could be done by a boy. The result of this is, that when graduates, in the first year or so after leaving college, find their work not very inspiring, most of them think, and some have even been known to complain to their superiors, that the work they are given to do is not suited to their abilities. This is one cause of the dissatisfaction of recent graduates, and of the desire on the part of employers to let some one else take the graduates in hand for the first two years till they learn what life and work really are.

The student in the commercial shop learns both the powers and the limitations of the "practical" man, who has had experience but little education. He sees that an uneducated man may be clever enough to accomplish a great deal without theory, but that, on the other hand, he, the so called "practical" man, wastes time and money attempting impossibilities, from which a very moderate amount of theory would have saved him. A student who fails to estimate practical experience at its true value, and who does not take advantage of every opportunity to learn from an uneducated man who has had more experience than he, will limit his usefulness just as much as the workman who refuses to listen to the student because he regards him as an unpractical theorist. He who would discover new truth, should first learn from both men and books all that has been previously discovered. He is then ready, by experiment or cogitation, to do his part. To disregard practice or theory is equally sure to lead to disaster.

There are other things which can best be learned in a commercial shop, besides the true valuation of practice and theory. The student learns the names of all the little things in daily use; he becomes familiar with keys, feathers, dies, cotters, and many other things that are strange to him, and thus saves his college instructor many long, weary explanations. But most important of all, he learns to understand workmen.

It should be remembered that the best paid positions, and those in which the work is most agreeable, are executive. Prof. Furman has published a record of the graduates of Stevens Institute which shows this very clearly, and he comes to the very important conclusion that a large percentage of the older graduates who now stand highest in their professional work, are those who started in as machine-shop apprentices. It seems evident that one reason for this is that they learned in the shop to understand workmen. Workmen are as necessary in production as iron and steel, or machine tools, and one who does not understand the ideas and point of view of the workmen, one who has not himself learned to serve, can not direct them to the best advantage. And the only way to come to a thorough understanding of workmen is to work beside them as one of them.

It might be claimed that although the ordinary college shop should be abandoned, the advantages of the commercial shop might best be obtained by the Worcester plan or by work during the summer vacation. The same objection holds good for both, that the student is in, but not really of the shop. To get the

full benefit of shopwork, the student must be, and feel himself to be, just like the other apprentices. He must not be a "special apprentice," but just "apprentice." With the Worcester plan there would inevitably be a certain academic spirit about the shop which would make the students feel that they were playing at work, rather than really working; and any cause for such a feeling would have to be guarded against, in any attempt, in accordance with the Cincinnati plan or otherwise, on the part of a technical school to lay out a course of shopwork for students in commercial shops.

Summer work in a commercial shop seems to last hardly long enough for the student to settle down to the dull routine. His mind would be on the approaching deliverance in the fall, rather than on the work at hand, and he would not think it worth while, for so short a time, to make friends with the other workmen. But if he had a year ahead of him, or possibly two, he would have to settle down to a steady gait; he would learn to know and to understand his fellow workmen and their point of view.

If the above reasoning is sound, and it is admitted that shopwork is best done in a commercial shop, the question still remains what is the best time for a student to begin his practical work, and for how long a period should it last?

A student should not enter a shop at too advanced an age because he is then apt to think it beneath his dignity to get his hands greasy. As an employer of student labor expresses it, "A young man who has put in four years of his young manhood getting a university education cannot get into the shop atmosphere even if he does don overalls and work at the bench or run a machine as a regular hand—such men have passed beyond the age and experience at which boys freely ask questions and learn quickly all those little details which are such an important part of the training and experience of shop men. They feel that they cannot afford to be laughed at; they do not want to expose their ignorance." This objection to the plan of post graduate "student courses" has still greater force where, as at Harvard, the training of an engineer extends over more than four years.

Prof. Kimball, of Cornell, suggests that the preferable time for a student to leave his studies would be at the end of his Junior year, "or just after he has attained his fundamentals, and just before he selects his specialty." In most technical schools a student might be said to select his specialty before the end of his Junior year, and perhaps Prof. Kimball would agree that, in such cases, it would be better to take the commercial shopwork earlier in the college course. At the Technische Hochschule, Zürich, it is not unusual for students to spend two years in a shop after the Sophomore year. F. W. Taylor, speaking before the Society for the Promotion of Engineering Education, said, "I believe that every young student in our colleges—from the student who intends to be a minister, on the one hand, to the mechanical engineer on the other hand—I believe that every student should leave college at the end of his Freshman year and spend at least one year in actual hard work in a shop of some kind."

Boys are not wanted in the industries until they are sixteen, and even at that age they are not mature enough to leave home with safety, nor to derive the greatest possible benefit from opportunities in a shop. It is also seldom that a boy decides upon his vocation until the last year in the high school, or later than his Freshman year in college. While it does not seem to me necessary that a student should defer his shopwork until he is ready to specialize, he should at least decide on his vocation before selecting the firm with which he is to undertake his practical work, and this is true even if we agree with Mr. Taylor that all good citizens should work for a year in a shop, if only to learn to know men. For these reasons I am inclined to believe that the year or more of practical work had best come either just before or just after the Freshman year in college. The period just before the Freshman year has the advantage that it requires one less change of residence, and the practical experience comes early enough to have an influence on the whole four years of college life.

Those who advocate a continuous period, summer and winter, of work in a commercial shop before graduation from college, agree that it should last not more than two, nor less than one year. In 1906 a committee of twelve English engineers presented a most interesting report to the Institution of Civil Engineers, after considering 267 replies to a circular letter sent to engineers and professors of engineering. They recommend for all kinds of engineers a year or two of practical work, spent in mechanical engineering workshops, and to be taken either between school and college, or "after the first year of college training common to all branches of engineering." The committee said further, "The longer period may be desirable in the case of boys who are to become mechanical engineers, and useful in all cases when boys leave school at 16 years."

When the workshop course is extended beyond two years, it becomes a serious question whether the loss will not be greater than the gain, because the student not only forgets what he has learnt, but also, from lack of practice, loses the ability to study. Even with the introductory workshop course limited to not over two years, the English committee expressed the opinion that "it is most important that all boys should at least maintain their scholastic acquirements during the introductory course, and for the class of boys in question, it is considered that this result might be secured by private tuition, or otherwise, without undue physical strain." As private tuition is not as customary nor as readily obtained here as in England, I am inclined to believe that one year would be the preferable length of the shopwork course. More accurately speaking, the time available would be from June of one year until October of the next.

The system which we have last considered, that of requiring at least a year of practical work before graduation, has been in use in Germany for a number of years. The student is allowed great liberty in his choice of work, but experience with a firm engaged in building machinery is preferred. In order to get college credit for his practical work, the student must bring a certificate from his employer which clearly shows the kind of work on which he has been engaged, and that during his year of practice he submitted without exception to the rules of the factory, or other industrial enterprise.

Perhaps the most interesting part of the German plan is the effect upon the instruction at the technical schools of having the curriculum relieved from shopwork, and of receiving students, having when they enter some idea of shop processes. At Charlottenburg, for example, there is no college shop, and laboratory teaching is confined to the engine and electrical laboratories, with a little practice in testing materials. There is a much larger amount of time given to machine design than is usual in American schools. This department is under the direction of Prof. Riedler, who carries on a large engineering practice, employing about 25 draftsmen, most of whom take part in teaching mechanical drawing and machine design. Thus to all intents and purposes the students are working under commercial drafting-room conditions. With shopwork and drafting-room work both taught in such a practical manner, it seems as though the German method, if applied to this country, could not fail to produce the kind of graduates our manufacturers stand in need of.

One objection sometimes made to work in a commercial shop is that the interests of the employer and of the student are naturally antagonistic; that it is for the employer's interest to have the student become a specialist at one machine, while the student naturally wishes to try his hand at every machine and learn to operate them all. However, manufacturers as well as students suffer by the present state of engineering education in the United States. Manufacturing has now become such a complicated matter that foremen, as well as chief engineers, managers and superintendents, need to have an engineering education. Manu-

facturers find it too expensive in loss of material and damage to machines, to teach employees to operate all machinery so as to fit them to be foremen, and they are thus compelled to get their foremen from other shops or from Europe.

The result of all this is that the manufacturer is as anxious as is the educator to discover some method of giving students the kind of training that will fit them for his purposes, and he grasps eagerly at any plan which seems to promise good results. The success of the Cincinnati plan and of the Fitchburg plan (a similar arrangement between manufacturers and technical high schools), as well as the "Sandwich" system in Great Britain, goes to show that manufacturers would adopt and work in harmony with students and professors under any reasonably equitable arrangement which would give promise of supplying them with suitable executives.

There are those who claim that our system of shop training is justified by its results; that we are doing very well as we are. The opinions already quoted would tend to disprove this assertion, but it may be pertinent to note the reasons why it is so easy to fall into this error. It is not always realized how much we are helped from outside. Go through any of the large shops and note the number of foreign names, and what is more important, foreign accents. A foreign name does not necessarily imply a foreign education, but a foreign accent does. We not only send Americans abroad to study, but we import foreign engineers and foreign designs. Most of the large sized gas engines, steam turbines and centrifugal pumps are patterned after European models, if not actually designed abroad. Even the Francis turbine, which originated in this country, was placed on a scientific basis in Europe, and imported back again.

It will probably be feared by some, that students could not afford the extra time and money necessary for the year of practical work. I believe, however, that there should be, in the long run, no financial loss from the extra year of training, but on the contrary, considerable gain from the increased ability of the graduates. This would certainly be the case if it can be assumed that manufacturers, under the German system, would pay the same wages to students as under the Cincinnati plan. In Cincinnati the students are paid at first 10 cents an hour, with an increase of one cent an hour about every six months. As the student works four years in the shop during his six-year course, his total earnings would amount to about $2000. That is, by spending two more years at college than the ordinary student taking the four-year course, the coöperative student earns $2000, or $1000 per year. This is about as good a salary as a man, just after graduation, could expect. Of course, the student has lost his summer vacations, and much time otherwise spent to little advantage in college, but his increased value to his employer and to himself ought to be ample compensation for the sacrifice.

The German system should appeal most strongly to a technical school which now has no college shop or a very poor one, so that the adoption of the German system would cause a saving of expense, rather than a waste in making useless a considerable investment. However, in any case it would be wise to adopt the best educational method, remembering the policy of the Carnegie Steel Co. to scrap anything from a bent pin to an inefficient plant as soon as a better could be secured.

To summarize the writer's conclusions: It is generally admitted that the usual American method of giving training in shop work in a college shop does not produce the kind of graduates desired by employers. Of the methods suggested as substitutes, the General Electric Co.'s plan of post-graduate courses is not generally available for mechanical engineers; the Worcester plan of a commercial shop operated by a technical school, and the Cincinnati plan of concurrent work in a commercial shop and at a technical school are feasible only under specially favorable circumstances, and in any case fail to give the graduate that knowledge of men which is essential to success in the highest executive positions. The German system of requiring at least one year of practical work as a prerequisite for graduation, has a beneficial effect on the whole college course, and has been recommended after a thorough investigation by a committee of the Institution of Civil Engineers of Great Britain. The conclusion is therefore that the German system ought to be adopted in the United States.

A Tar-refining Plant has been installed at the municipally owned gas works of Stourbridge, England, and was described as follows, in a paper by C. H. Webb, engineer of the works, at a meeting of the Institution of Municipal and County Engineers, at Stourbridge, on July 6:

In view of the demand for tar for road purposes, a Wilton's tar dehydrating plant has recently been installed. The special feature of this particular plant is that it is on the inclosed system, the tar being dealt with in a slow continuous stream instead of in bulk.

By this means the constancy of the finished product is more readily assured, and this is an important point when working to the Road Board's specification, which can be done with this plant. The principle of the process is that the tar is heated (to about 160° C.) when under pressure (about 30 lb. per sq.in.), and then released, when the water and light oils, being at a temperature higher than their respective boiling points, are evaporated, and leave the dehydrated and acid-free tar behind. The plant at Stourbridge is capable of dealing with 100 gallons of crude tar per hour.

The tar is supplied from the land sale tank by gravity into a suction or feed tank, from which it is continuously pumped through a preheater or economizer, the coils of which are surrounded by hot dehydrated tar. After absorbing some of the heat in this, the crude tar then passes to the still, which is a brick structure containing about twelve laps of coiled piping, heated by a small breeze furnace with forced draft. The crude tar when passing through the coil is still further heated, and on leaving the still the pressure is suddenly reduced in the vapor box, where there is a free space provided. The water and light oils being at a high temperature are vaporized, and leave the tar, which latter flows away through the preheater, where it parts with some of its heat, on to the store tank for sale. From the top of the vapor box the vapors pass through a coiled condenser surrounded by cold water, and thence to the receiver, where the ammoniacal liquor and light oils separate by gravity. The liquor is run back to the works well, while the light oils are barreled and sold. The plant is simple, easily worked, and, from the reports received from other works where the process has been carried on for extended periods, gives very little trouble.

As the greater proportion of the dehydrated tar will probably be required in the summer months, when the gas works output is at a minimum, it is essential that there should be ample storage for crude tar, and also to allow for rushes of work on the roads when the weather is fine, there should be good storage for the finished product.

As road engineers you are doubtless most keenly interested in keeping the cost of the dehydrated tar as low as possible, and, consequently, your attention should be directed toward insuring that the barrels used for packing should be treated by your men with the greatest care, and returned promptly. To pack a ton of dehydrated tar five barrels are required, costing at present prices 5s. each. As the cost of these barrels has to be charged in the price of the tar it will be seen that if the barrels can be made to last an increased number of journeys, say eight instead of six, before being scrapped, the cost of packing per ton is reduced from $1.04 to $0.78, or over 25c. per ton.

Experiments with Road-surfacing Materials are in progress on Hillside Avenue, in the town of Jamaica, Borough of Queens, New York City. A section of the street, 2000 ft. in length, was paved in 1895, with waterbound trap-rock macadam, 6 in. thick, which was resurfaced in 1905. The paved width is 25 ft. This street was resurfaced in August, 1911, with nine different kinds of coatings, as follows: One of oil-cement concrete, four of bituminous macadam, laid by the penetration method, using various binders, and four bituminous concrete pavements, laid by the mixing method, with different binders. The report of the work done in laying these pavements has just been published by the office of Morris E. Connolly, President of the Borough of Queens. These experimental pavements were laid under the direction of a committee, of which Nelson P. Lewis, chief engineer of the Board of Estimate and Apportionment was chairman, and the other members were L. W. Page, Director of the Department of Public Roads, and Messrs. John M. Goodell and John H. Weinberger.

This report covers only the work done in the laying of pavements, with the tests of the bituminous road binders used, and the results of a traffic census taken in October and November last, which census indicated a traffic averaging 1000 to 4500 vehicles per day, over three-fourths of which were automobiles. The report contains nothing concerning the condition of these roads after nearly a year of wear, except the statement that this condition is to be determined by inspection made by representatives of the U. S. Office of Public Roads, the results of the inspections to be published from time to time by that office.

Bleeding Steam from Receivers of Triple Expansion Engines for Heating Feed Water

By Geo. M. Peek*

Data on this subject seem to be rather meager. In fact, the writer has not been able to gather anything definite. The reason for this lack of reliable data may be found in the fact that it is not often the case that engine builders have been required to guarantee a plant, or overall duty, consequently they have not deemed it of sufficient financial importance to them to incur the expense necessary to obtain these data. On the other hand, the purchaser generally needs his engine as soon as possible after the same has been erected, consequently he has done practically nothing toward this investigation.

Those in charge of water-works plants are in a very good position to do work of this character, because a properly equipped pumping station always has an extra pumping unit in order to insure against a shut-down in case it is necessary to make repairs to a unit which is in service.

At the suggestion of L. A. Day, Mechanical Engineer in charge of the Construction Department of the St. Louis Water-Works, an investigation was started to see if a saving could be accomplished by connecting feed-water heaters, for heating the boiler feed water, to the receivers of the triple expansion pumping engines in No. 1 Station.

Preliminary calculations were based on the following assumptions: that an equal amount of work is being done in each cylinder of the engine and that steam taken from the first receiver will have done one-third of its work and steam drawn from the second receiver will have done two-thirds of its work. By running the feed water through a heater attached to the second receiver, its temperature could be raised to nearly that of the steam in the second receiver; the water then passing through the heater attached to the first receiver, its temperature could be further increased to nearly that of the steam in the first receiver. The water is then fed to the boiler at this temperature. Besides the actual saving in heat units the stresses on the boilers would be materially reduced below those caused by forcing cold water into them.

The boiler pressure was 150 lb. by gage. The pressure in the first receiver, when running under normal conditions, was 30 lb. and the pressure in the second receiver was −2 lb. It was further assumed that the water from the hotwell, with a temperature of 90°, could be raised to 200° by passing it through the heater attached to the second receiver and to 260° by passing through the heater attached to the first receiver.

In order to simplify the problem, the condensed steam from the receivers was not considered as mingling with the water in the hotwell. It was also decided not to consider the quality of the steam in the receivers, as we were not in a position to conveniently determine this. Neglecting the moisture, simplified the calculations, and by so doing the saving as figured would be slightly lower than if the moisture was taken into account because it has a certain amount of heat which would be available for heating the feed water.

The problem was solved in the following manner:

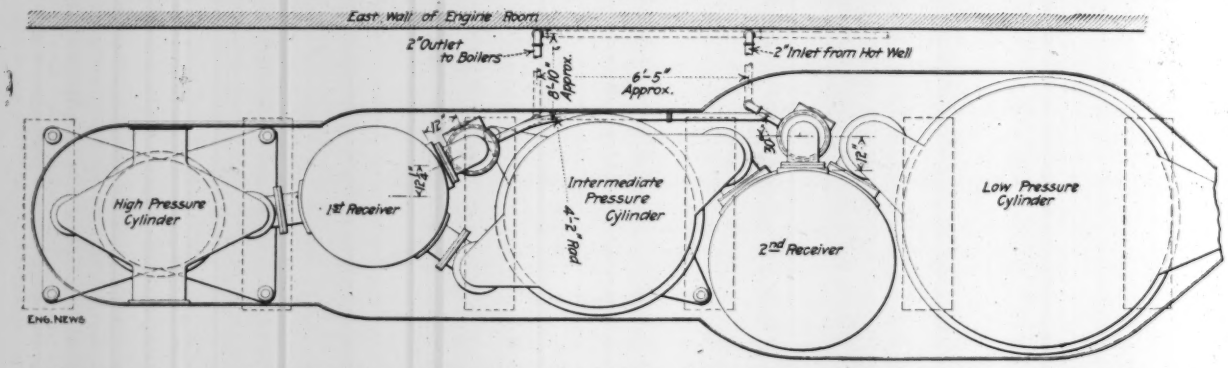
Let

X = Increase in steam, in pounds per hour, which will have to be delivered to the engine in order to make up for the steam taken from the receivers;

Y = Pounds per hour of steam taken from the first receiver;

Z = Pounds per hour of steam taken from the second receiver;

9570 lb. per hour was assumed to be the steam used by the engine before the heaters were attached. This figure was obtained from the official test of the engine when it was running under contract conditions. The amount of water to be raised from the temperature of the hotwell (90°) to that of the heater of the second receiver (200°) will be $9570 + X - Y - Z$. Since we will have Y pounds of water at the temperature of the heater of the first receiver and Z pounds of water at the temperature of the heater of the second receiver, neither of which quantities will have to be raised from the temperature of the hotwell to that of either of the heaters. The Z pounds of water will have to be raised from 200° to 260°, therefore we must raise $9570 + X - Y$ lb. of water from 200° to 260°. Since we assumed the engine to do equal amounts of work in each cylinder we must add to the steam delivered to the engine two-thirds as much as we take from the first receiver and one-third as much as we take from the second receiver, therefore we have the following equations,



General Plan of Triple-Expansion Pumping Engine, Showing Feed Water Heaters Attached to Steam Receivers

$$(9570 + X - Y)\ 61 \div 928 = Y \quad (1)$$

$$(9570 + X - Y - Z)\ 111 \div 972 = Z \quad (2)$$

$$\tfrac{2}{3}\ Y + \tfrac{1}{3}\ Z = X \quad (3)$$

where

61 = Difference between the heat of water at 200° and at 260°;

928 = Latent heat of steam at 30 lb. gage pressure;

111 = Difference between the heat of water at 90° and at 200°;

972 = Latent heat of steam at −2 lb. gage pressure.

Solving the above we find

$X = 756$, $Y = 642$, $Z = 992$.

Therefore, the steam required for the engine, after the heaters are attached, would be $9570 + 756 = 10{,}326$. Consequently before the heaters are attached we must evaporate 9570 lb. of water from 90° into steam at 150 lb. pressure and after the heaters are in commission we must evaporate 10,326 lb. of water from 260° into steam at 150 lb. pressure. Reducing these two quantities to evaporation from and at 212° we find that before the heaters are used we must have

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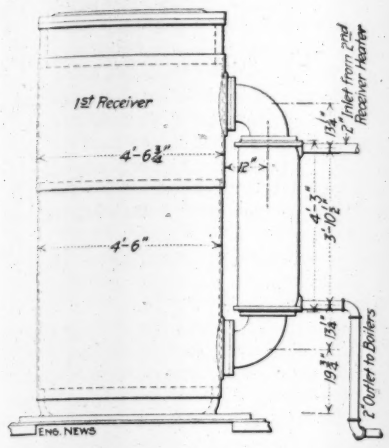


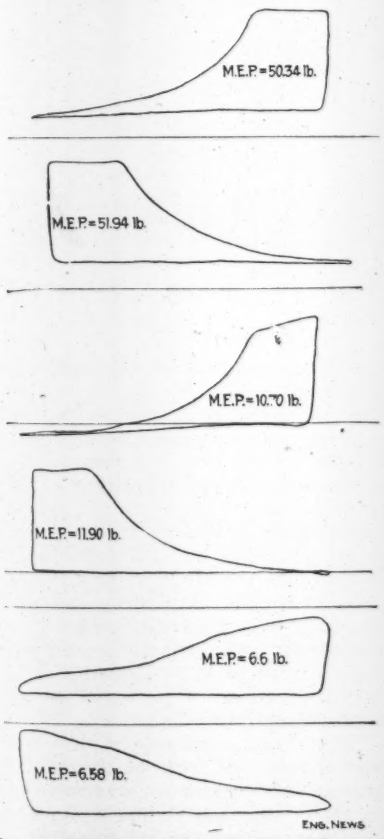
ELEVATION OF STEAM RECEIVER BETWEEN HIGH-PRESSURE AND INTERMEDIATE CYLINDERS, SHOWING FEED-WATER HEATER ATTACHED

9570 (1.1717) = 11,213.2
and after the heaters are attached
9570 (0.994) = 10,278.5
difference = 934.7
Therefore we could make a saving of
934.7 ÷ 11,213.2 = 8.33%.

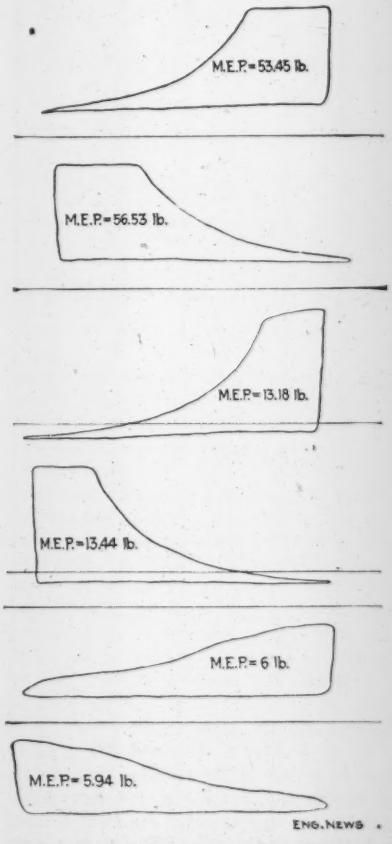
This seemed to indicate quite a large gain. After discussing the matter with prominent engine builders and not being able to get a definite opinion from them as to whether or not we would be able to actually obtain such a saving as these calculations would indicate, it was decided to equip one engine with the heaters and run some careful tests on it before going to the expense of equipping the other two engines in the station.

The engine to which the heaters were attached was a 34-in., 62-in. and 94 in. by 72-in. 20,000,000-gal. triple-expansion with 34-in. single-acting pumps built to work against a pressure of 100 lb. in the discharge main. Each piston has two 4⅝-in. piston rods.

The drain pipes were arranged to deliver all drains from the jackets and receivers into the hotwell with the water from the condenser. When the data for the preliminary calculations were obtained, the drains ran through a coil in the hotwell so as to avoid getting grease into the boiler feed water. Since it is proposed to install grease extractors and run all drains direct into the hotwell the tests were conducted with the drain pipes arranged in this manner. This accounts for the higher hotwell temperatures on the tests than were assumed in the preliminary calculations. When running the tests a separate boiler feed pump was used instead of the pump direct-connected to the engine.



INDICATOR CARDS WITHOUT FEED-WATER HEATERS



INDICATOR CARDS WITH FEED-WATER HEATERS

TABLE I

	Data obtained from tests	Without heaters	With heaters
1	Barometer, in.	29.46	29.59
2	Outside temperature, deg. F.	59.00	68.37
3	Steam pressure, lb. by gage	155.25	155.76
4	Steam delivered to the engine per hour, lb.	7189.71	7497.00
5	Head between the wet well and discharge main, ft.	8.60	8.60
6	Water pressure in discharge main, lb.	82.00	81.96
7	Total head pumped against, ft.	197.54	197.44
8	First receiver pressure, lb.	30.00	33.58
9	Second receiver pressure (vacuum) lb.	1.85	3.27
10	Vacuum in condenser, lb.	13.75	13.75
11	Weight of water from condenser air pump	6178.71	5560.00
12	Temperature of condenser water, deg. F.	96.40	103.125
13	Weight of trap water (receivers and jackets) lb.	1011.00	1937.00
14	Temperature of trap water, deg. F.	187.31	188.80
15	Temperature of water at feed pump (observed), deg. F.	102.50	124.40
16	Temperature of water at feed pump (calculated), deg. F.	109.21	125.43
17	Temperature at entrance to heaters, deg.	.....	120.70
18	Temperature between heaters, deg.	.....	190.00
19	Temperature leaving the heaters, deg.	.....	270.70
20	Temperature of cooling water in, deg. F.	64.76	73.00
21	Temperature of cooling water out, deg. F.	75.40	82.70
22	Revolutions per hour.	875.28	852.14
23	Gallons per revolution allowing for slip.	792.20	792.20

TABLE II

	Calculated from data in Table I	Without heaters	With heaters
1	Water horsepower delivered by engine.	576.00	565.20
2	Steam per horsepower per hour, lb.	12.482	13.264
3	Factor of evaporation.	1.1524	0.986
4	Equivalent pounds of steam per horse per hour from and at 212 deg.	14.384	13.078
5	Difference, 14.384 — 13.078 = 1.306.		
6	Saving, 1.306/14.384 = 9.0%		
7	Engine duty (ft. lb. per 1000 lb. steam).	158,649,000	148,070,000

Table I shows the principal data obtained during two of the tests. The figures given are averages, readings being taken every 15 minutes. Each test was run for seven hours. The difference between the temperatures as observed in line 15 and that as calculated in 16 was due to the fact that the trap water was weighed in a separate tank and was not dumped into the temporary hotwell at the same time as the condenser water was. On this account the thermometer readings showed considerable fluctuation. It will be noted that there was a drop in temperature between the entrance to the feed pump and entrance to the heaters; this will be reduced when the pipes are thoroughly covered.

Table II shows the results calculated from Table I.

If, instead of assuming data as was done in the preliminary calculations, we take the actual data as obtained from one of the tests as follows: steam pressure, 155.76 lb.; total steam, 7189.71 lb.; temperature of hotwell, 109.21°; temperature between the heaters, 190°; temperature leaving the heaters, 270.7°, and load distribution as obtained from the indicator cards 37% in H.P. cylinder, 31% in I.P. cylinder and 32% in L.P. cylinder,

and figuring as indicated by the example above it will show a saving of 7.76%.

In order to get a further check a coal test was run. This, however, was a very rough check because two pumping engines were running, only one of which had the heaters on, all auxiliaries were drawing steam from the boilers as also an engine used to run the machine shop. Nevertheless, there was a sufficient saving to give a fair check on the above figures.

It will be noted that there is a small loop in the lower I.P. card taken without the heaters in service. This was probably caused by the water pressure being below the average at the time this set of cards were taken.

It might be mentioned that the manufacturer's duty guarantee for this engine was 135,000,000 ft.lb. per thousand pounds of steam.

The Service Equipment of a Combined Theater and Office Building

By W. A. Ehlers*

As the mechanical, electrical, stage and general service equipment of the Riggs theater and office building, being erected at 15th and G Sts. N. W., Washington, D. C., are somewhat out of the ordinary and unusually complete, the writer believes that a description of some of the features involved would be of wide interest.

The building has a frontage of 116x178 ft. and is eight stories high. The theater section occupies about two-thirds of the floor area and has an entrance on 15th St., with all exits on G St. The auditorium extends to the level of the sixth floor of the office section and the stage portion occupies the entire height of the building. On the first floor of the office section, in addition to the theater entrance, are a large cafe, two general stores, and an entrance to the offices. The general offices occupy the whole of the office section above the first floor and three floors over the theater auditorium. In the basement is an elaborate Turkish bath with a swimming pool, a large barber shop, a theater promenade and various theater facilities like trap, wardrobe, and animal rooms, a green room and various quarters for musicians, porters, ushers, etc. The boiler, mechanical and engine rooms are in the sub-basement.

Heating and Ventilation—An indirect single-duct plenum system of heating and ventilating is used. Fresh air enters through an intake in the outside wall near the roof, drops down through an air shaft to steam tempering coils in the sub-basement, and passes through washing and humidifying apparatus for the removal of dust, soot, etc. This washing is by water sprays in a large duct, suspended water particles being eliminated by passing baffle plates. The air on leaving the water is expected to contain not more than 2% dirt or dust in suspension. After washing, the air is forced over cast-iron reheating coils and into a warm-air tunnel and ducts leading to the plenum chamber directly under the auditorium floor. For this movement, a 35-hp. blower is required. From the plenum chamber the air is led to various points of the theater through galvanized-iron ducts, the actual outlets to the auditorium being mushroom heads placed in the floor, under each chair. The theater promenade, the barber shop, and the Turkish bath are also heated by warm air from the plenum chamber. In the toridorium, tepidorium and steam room of the Turkish bath, the warm-air supply is regulated by thermostats and diaphragm dampers; these three rooms also have direct radiation controlled by thermostats and diaphragm valves. Live steam from the steam main (between boilers and engines) is taken through a pressure-reducing valve to 2-in. pipe coiled around the four sides of the room above the door. In the steam room there are also two 1-in. pipes, 6 ft. long, drilled with ⅛-in. holes placed under the radiator coils and controlled by a thermostat so that the amount of steam let in can be adjusted to keep the temperature at from 70° to 100°. Exhaust from the heating coils is trapped and led to the vacuum pump.

There is also a low-pressure direct-heating system in the building in addition to the warm-air supply. It has three parts, each separately controlled and operated for (1) offices, (2) theater, and (3) for the barber shop. Exhaust pipes from the engines in the sub-basement run up to the roof where they are controlled by a back-pressure valve, beyond which the above three branches are taken off and sent downward throughout the building. Each heater is individually controlled by a hand valve and by an automatic thermostat. The discharges from radiators are piped to risers and section returns which are gathered into a header leading to a gleaner heater and the vacuum pumps. The gleaner heater circulates heating water for the exposed roof tanks.

The air piping for the temperature control of the building is divided into three sections—for the offices, theater and Turkish baths. There are 1-in. main risers to the loft for each service and from these are run ¾-in. floor mains which in turn supply the lines to the various thermostats. For return lines ⅛-in. pipes lead from the thermostats to the radiator valves.

The temperature of the air supply taken in for the theater, etc., is first regulated by a cold-air thermostat at the intake, controlling the first section of the tempering coil. There is a second thermostat in the duct from the air washer controlling the inside section of the tempering coils, to keep the incoming air at about 70°. The air intake also has a removable diaphragm-operated by-pass damper with thermostat control between the two banks of tempering coils, to pass all or only a portion of the air supply through the coils.

The exhaust ventilation system has three sections, one from the theater, one from the theater basement, and one from the barber shop and Turkish bath. The foul air is collected into galvanized ducts and led to the roof, by motor-driven

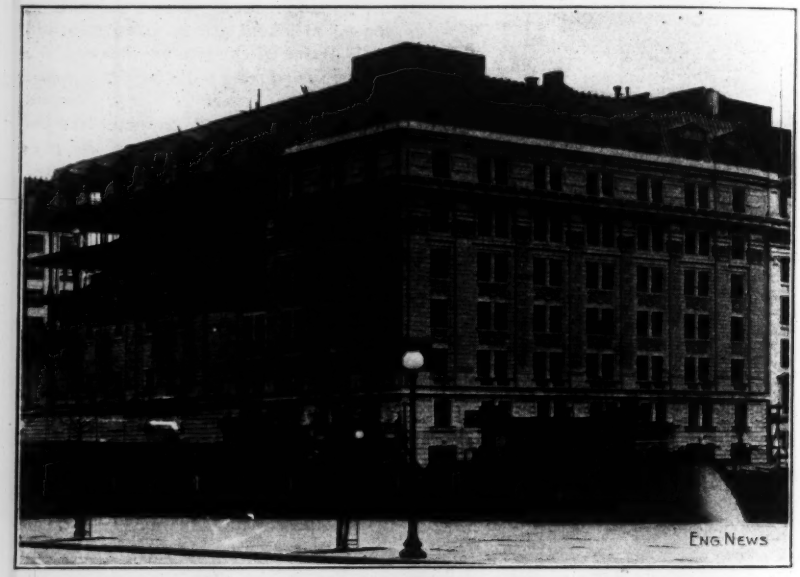


Fig. 1. The Riggs Theater and Office Building, Washington, D. C.

*Superintending Engineer for J. H. De Sibour, Architect, Hibbs Bldg., Washington, D. C.

blowers in each main duct. The motors are remote controlled so that fans can be started, stopped and changed to any desired speed from the main switchboard in the engine room. When it is desired to fix the speed the controller can be locked so that the operator cannot run the machine at either under or over speed. Moreover, when the fans are started which control the fresh air supply the same control circuit starts the exhaust-fan motors and the spray-water pump for the washers.

WATER SUPPLY SYSTEM — The city mains in 15th and in G Sts. are tapped for a 6- and a 4-in. supply line, respectively. These are brought together in the building at an 8-in. header. In this header is a sand screen which serves as a fish trap, and a detector meter used in place of a regular 8-in. type, being much less expensive and answering all purposes of a meter at this point.

From the header the water is fed to the building in several ways. First, it passes through a 4-in. valved line and a meter into a closed house tank, 6 ft. in diameter and 12 ft. high, automatically controlled by means of float valves. The first header is also directly connected into a second or street-pressure header from which the various service-supply lines are led off to the separate portions of the building. As the water-supply system of Washington at present is capable during heavily taxed seasons, of elevating the water with sufficient pressure only to the level of the fourth floor, a higher pressure pump and supply tank is installed. The fixtures on the floors of the office section are fed upward by city pressure that far and they are cross-connected to house-pressure supply lines so that they may be under either pressure. The offices over the theater auditorium are fed from a down supply in the attic, which in turn is supplied from the house-pressure tank. The latter is also directly connected (by straight valved lines) to the standpipe lines (fire-hose connections, with two outlets on each floor and at various points in the theater), keeping them always under house pressure. The house-pressure pump and tank are bypassed so that, in the event of city pressure being so increased in the future as to elevate the water to the full height of the building, the present pumping equipment may be cut out.

The street pressure is also carried to an open receiver for the hydraulic curtain and carpet lift of the stage and there automatically controlled. From this receiver in the sub-basement, sprinkler pumps elevate the water to the sprinkler tank of 17,000 gal. capacity above the roof. The sprinkler pumps are (1) an 8x5x10-in. horizontal steam pump, and (2) a 6x8-in. triplex electric, both designated to elevate 95 gal. per minute, against 60 lb. pressure. The electric pump is provided with an automatic controller so that it starts on a 5-lb. drop of pressure below that of the steam pump. The discharge from the sprinkler tank is

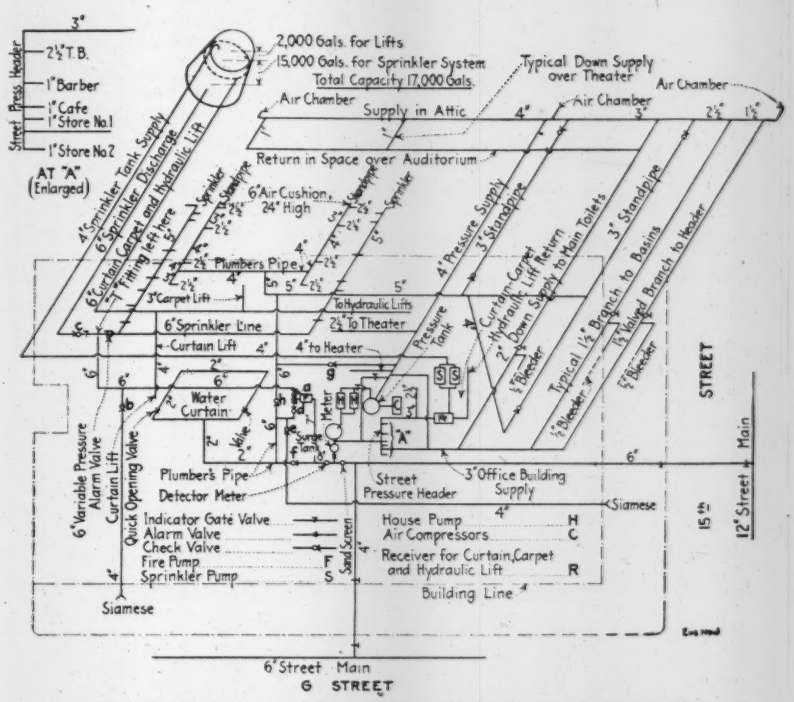


FIG. 2. DIAGRAM OF WATER-SUPPLY SYSTEM; RIGGS BUILDING

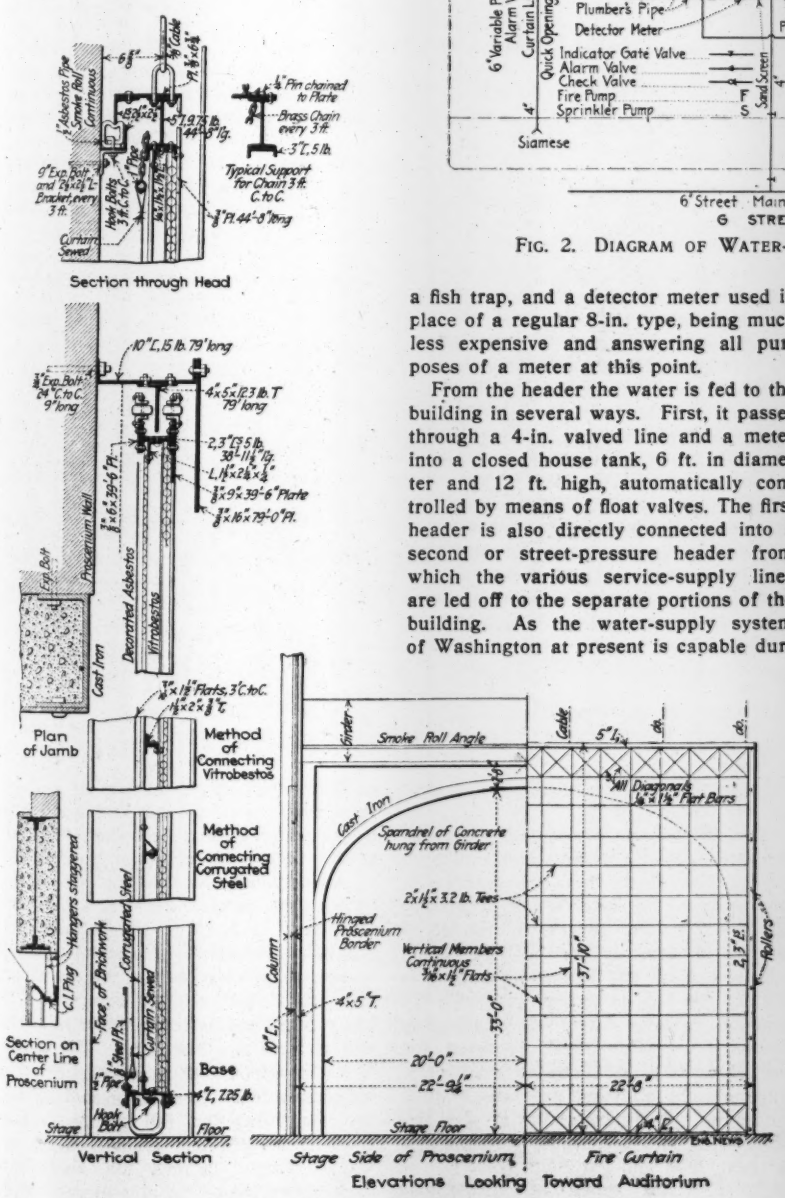


FIG. 3. FIRE CURTAIN DETAILS; RIGGS BUILDING

arranged so that at least 15,000 gal. must be delivered to a sprinkler system and 2000 gal. near the top may be used for operating the curtain and carpet lifts. The sprinkler system also supplies the stage water-curtain which is formed by 2-in. valved lines from the 8-in. header extending up on each side of the stage curtain, making a continuous pipe entirely surrounding the proscenium opening. This pipe is perforated with ⅛-in. diameter holes across the entire width of the proscenium arch so as to throw water on the stage side of the fire curtain. Each riser on the side of the curtain is controlled by separate quick-acting valves.

To satisfy the District of Columbia building regulations and the requirements of the National Board of Fire Underwriters, the water supply for fire protection was specially arranged. In event of fire, a 16x9x12-in. steam duplex pump, having a capacity of 1000 gal. per minute is started. The pump suction is connected to the 8-in. street-pressure header and the discharge to all the fire lines, which are supplied with check valves at various places. The pressure of the fire-pump discharge opens valve *a*, Fig. 2, closes valves *b* and *c* against the G St. siamese and sprinkler-tank discharge, respectively, passes through a variable-pressure alarm valve, and goes directly to the sprinkler pipes located throughout the theater. The alarm valve will indicate any serious irregularities in the operation of the fire pump by ringing when the pressure falls below a definite point. The fire pump will also open the check at *d*, Fig. 2, and close the valves at *e* and *f* against the 15th St. siamese and street-pressures, respectively. It will open the valve *h* and close *g* against the house pressure and thus put the water curtain of the theater and also the standpipes of the theater and office buidling under fire-pump pressure.

A further provision for fighting fire is seen in a siamese steamer connection on both street fronts. On the arrival of the fire department, steamers are connected to the above siamese outlets and started up. The fire pump may then be shut down if desirable or necessary and the standpipe and sprinklers placed under the steamer pressure. The siamese on the 15th St. line operates the standpipe and water curtain exclusively, by opening the checks *d* and *e*, at the same time closing the checks *f*, *b* and *g*. The siamese inlet on G St. will open check *b* and close the checks *c* and *a*, placing the sprinkler system under the control of this steamer.

For the hot-water circulating service, the 4-in. street-pressure supply line is tapped beyond the house-pressure tank and pumps. The water is passed through the two hot-water generators and fed to various fixtures of the building, being returned again and again to the generator and the 4-in. main supplying only the amount of water drawn off. Each generator is cross-connected, bypassed and valved so as to have one on street-pressure and one on pump pressure, or both on either. Each generator is also designed for 100 lb. working pressure and to heat 2800 gal. per hour from 50° to 160° F., with steam at atmospheric pressure.

The building has an ice-water circulating system, outlets being placed over the lavatories in each office as well as at other places throughout the theater. The make-up water for the system is taken from the street-pressure header, distilled, filtered and led over expansion coils on into an open receiving tank from which it is pumped through the building to various fixtures.

STAGE EQUIPMENT—The stage fire curtain is a six-point steel frame, 37 ft. 8 in. high by 45 ft. wide. As shown in Fig. 3, the top is made of a 5-in. I-beam, a 3-in. channel and a plate stiffener. There is a 3-in. channel and stiffener at each side and a 4-in. channel at the bottom. The interior of the frame is an interlocking web of T's, angles and plates arranged to thoroughly brace the curtain against all stresses. Details may be seen from the accompanying figure. Fastened to the proscenium wall on each side of the arch are structural sections and plates, which form a pocket in which the curtain slides, and serve also as a smoke seal. The curtain is counterbalanced to within 1000 lb. of its weight, this being the amount of the underbalance required to lower it by gravity.

The curtain is raised by a hydraulic engine made to lift the counterbalance of 1000 lb. and hold the curtain at any desired height with the head of water due to the water pressure received from the gravity tank of the sprinkler system. The engine is controlled from the stage floor by a ⅜-in. continuous steel cable running over 10-in. sheaves mounted over and below the stage. A three-way automatic-closing valve brings the curtain to a gradual stop without noise when it has reached the extreme height of travel and at the stage-floor level. The engine is also provided with an emergency valve connecting to an emergency cord release for controlling the fall of the curtain from nine different places above the stage. Simply cutting the controlling cord at any one of the nine places lowers the curtain quickly to the stage without

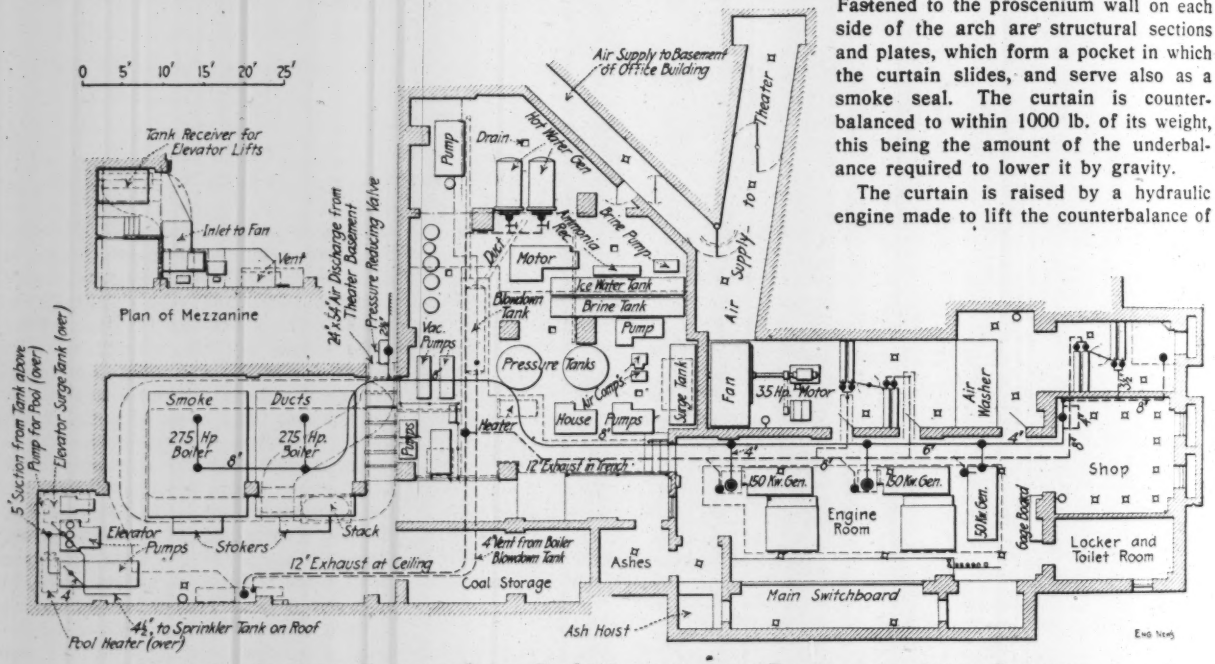


FIG. 4. SUB-BASEMENT PLAN AND POWER-PLANT LAYOUT; RIGGS THEATER AND OFFICE BUILDING

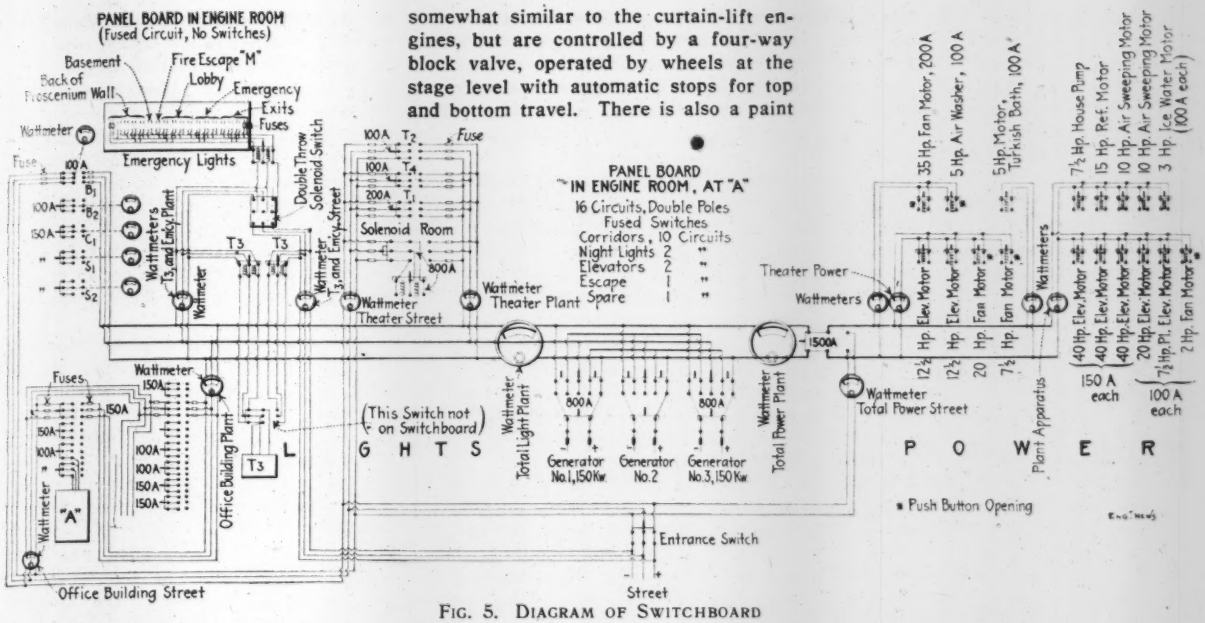


FIG. 5. DIAGRAM OF SWITCHBOARD

shock or noise and without further attention.

The stage has two hydraulic carpet hoists for raising a carpet rug weighing 500 lb. The engines of these hoists are somewhat similar to the curtain-lift engines, but are controlled by a four-way block valve, operated by wheels at the stage level with automatic stops for top and bottom travel. There is also a paint frame and hoist at the rear of the stage. This is a worm-gear type capable of raising a 5000-lb. frame and a 600-lb. asbestos curtain, holding it at any desired position.

The stage also has 70 sets of hand counterweight lines for raising and lowering scenery, the one-act curtain, six border lights, besides two carpet lifts, in connection with the hydraulic lifts mentioned. The equipment consists essentially of an elevating batten made of 1½-in. galvanized steel pipe, 42 ft. long, coupled together with pipe fittings in the usual way, to which the battens of the scenery roll are attached. Each elevating batten is carried by three lines which pass over the respective loft sheaves in a gridiron frame, thence to the side of the stage, over a three-groove sheave and to a counterweight.

Act sign-boards are placed in each side of the proscenium arch; they have a continuous paper strip rolled from a lower to an upper cylinder by a continuous rope running from a double-groove sheave on the lower cylinder to a single sheave on the upper cylinder. The second groove on the lower cylinder of each sign carries a continuous rope running through tension sheaves below stage and over a three-groove sheave under the center of the stage. From the third groove of the last sheave a continuous line is run over tension sheaves and to a last sheave on the under side of the right-hand spotlight gallery. By this scheme the signs can be easily operated from a point near the stage switchboard.

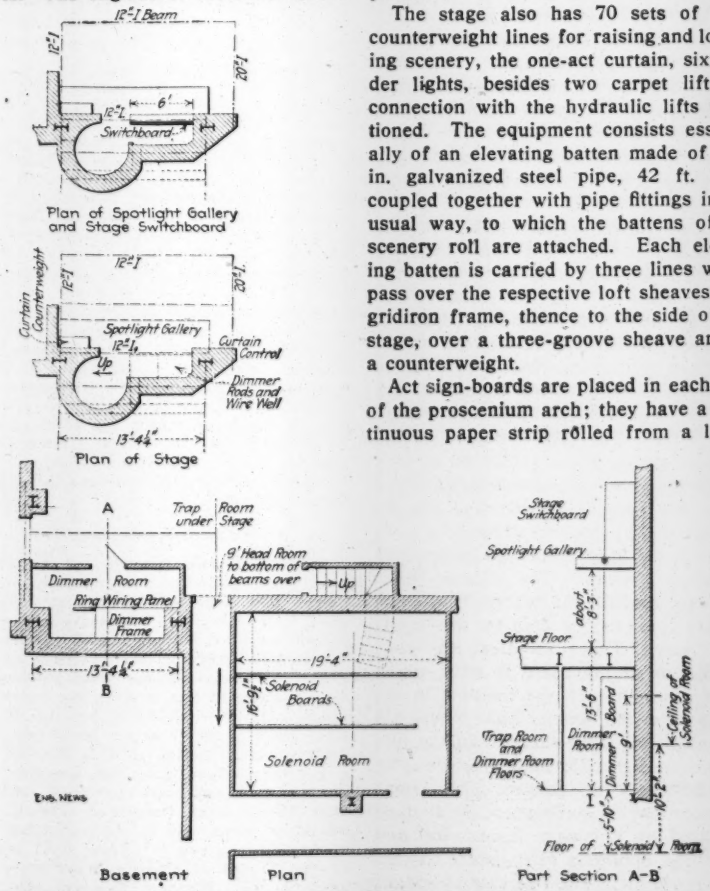


FIG. 6. LOCATION SKETCHES OF STAGE SWITCHBOARDS; RIGGS THEATER

POWER PLANT—A power plant has been installed capable of supplying all power requirements of lighting, heating, cleaning, etc., for the complete service of the building. There are two 275-hp. vertical water-tube boilers with mechanical feed-water filters and draft regulators. There are two 225-hp. engines direct-connected to 150-kw. generators, supplying the three-wire system. The boilers furnish steam also to the fire, vacuum, boiler-feed and one elevator-tank pump, and the house-cleaning system. All other pumps are electrically driven. The exhaust lines from the engine are run to the roof, as already noted, from where the exhaust steam is returned through the office radiators. Some exhaust is used also for the house hot-water supply, the swimming-pool circulating heater, and the rest in the boiler feed water. The condensation from the various heating apparatus is finally delivered at the boiler feed-water heater, first passing through a gleaner heater through which circulates the water of the sprinkling tank on the roof to keep it from freezing in cold weather. The boiler plant is equipped with weighing machines for

measuring the water used in connection with the hydraulic lifts and boilers. Each hydraulic lift has an open weigher which discharges into the tank receiver for the elevator; the boilers have a pressure type of weigher of 300,000 lb. per hour capacity placed between the feed pumps and the boilers.

For the ice-water supply there is installed an eight-ton two-cylinder compressor refrigerating machine together with an ammonia condensor and an ice-water circulating tank. As already noted, the make-up water is carried from the distilling apparatus through a tank in which are the expansion coils of an ammonia circulating system. A part of the ammonia coils are placed in a brine tank from which the cold liquid is pumped through cold-storage boxes of the cafe.

CLEANING EQUIPMENT—The building is equipped for vacuum sweeping and cleaning. The suction apparatus is of the simplest type, in which a steam-jet aspirator replaces a mechanical pump. There are two four-sweeper outfits. When the vacuum in the dust collector falls below normal this drop automatically opens a control valve admitting more steam to the aspirator and raising the vacuum. The entire building is piped for this cleaning service, including stores, offices, Turkish baths and barber shop, and suction is maintained at all times. The piping is as usual, with automatic stops at each outlet to close off the pipe when a hose is disconnected.

MAIN SWITCHBOARD—The lighting and power current, which is generated on the premises and supplied to a 110-220-volt three-wire system, is distributed to the various services from a main switchboard where are three panels for the generators, four for the lighting lines, two for power circuits and one for motor control. The main distribution switches are double throw and may be fed from a separate set of busbars leading to the lines of the local electric-supply company, for break-down service. There is another connection to the street lines, made beyond the street switch and leading to an automatic switch which throws the lights at the exit lobbies, on the stage and in the basement, and all emergency lights in the theater auditorium, on the central-station service when the house-plant current is interrupted; the house-plant connection is reëstablished as soon as its service is resumed.

On account of the various purposes for which the building is used and the fact that each department is entirely separate and operated by different lessees, a larger number of separate and distinct centers of distribution were required than ordinarily found in office buildings. The various lighting circuits are taken from between the neutral and positive or negative wires of the three-wire systems and are therefore 125-volt circuits. Eight general distribution circuits were needed: (1) store No. 1, (2) store No. 2, (3) café, (4) barber shop, (5) Turkish baths, (6) office section, (7) theater, and (8) emergency lights. Each of these general circuits is provided with a three-wire watt-hour meter and a 150-amp. three-pole, double-throw switch.

The general theater circuit, which does not include the emergency lights in the auditorium, has four subdivisions with separate distribution; (1) for the solenoid room where is the actual control of the stage and auditorium light, (2) for the distribution panel which controls all lights behind the proscenium arch, (3) for lights in the service portion of the theater basement, and (4) for the promenade and toilets. This subdivision had been arranged for economy and ease of control.

There is a motor-controlled panel on the switchboard for handling the different motors noted already under heating, ventilating, etc. The power circuits are taken between the positive and negative cross-wires and carry 220 volts. These control circuits are four in number: (1) for the indirect heating current of air washer, (2) for the Turkish baths, (3) for the theater elevators and fan motors and one for the service-plant apparatus (cleaning, refrigerating, etc.). The power circuit here is also controlled through a 1500-amp. double-throw switch so that the local company's service may be substituted for the isolated plant. Two two-wire 220-volt watt-hour meters are properly connected so as to read the total power on either supply. The four separate power circuits noted are also metered and have overload circuit-breakers.

THEATER SWITCHBOARD—The theater switchboard proper is a remote-control type and is located on the right-hand side of the stage facing the auditorium. There are control and dimmer boards in the spot-light gallery above the stage, the first operating the circuits running to the solenoid board in the basement and the latter operating the resistance frames below stage. The control board in the spot-light gallery has a double set of contacts so that while one combination is set for an act another combination can be prepared and by one movement of a master switch the illumination can be changed as desired instantly. The dimmer board is directly beneath the control board and here are operating handles for the resistance frame. These handles are connected back of the board to rods, which extend down through the building in the wire space to the dimmer room where are the resistances to be inserted in the different stage lights for raising or lowering their brilliancy as needed. All lamps of a color may be simultaneously dimmed if desired by a master handle for that color. The operation of the stage switchboard is simple. The operator by means of little buttons on the control board throws into operation the corresponding solenoid switches in the distant room and these throw on the current to the lighting circuits desired. Then by operating the control levers on the dimmer board, the desired amount of resistance is thrown into this circuit and the lights are cut down to the proper tone.

There are a number of circuits that are not run to the regular dimmers and these are led to terminals which may be connected to various combinations of special grids for operating arc lamps across the 110-volt line.

The general plans and specifications for the building were prepared in the office of J. H. De Sibour, of Washington, Architect, with I. H. Francis, of Philadelphia, and Marshall & Marshall, of Washington, as Consulting Engineers for the mechanical and electrical equipment and the steel construction, respectively.

The work of construction has been under the direction of the writer as superintending engineer. The general contractors were Wells Bros. Co., of New York City, with the American Bridge Co. sub-contractors of the steel work. The mechanical and electrical equipment is in the hands of the Biggs Heating Co., of Washington, with Kelly & McDonald, of Washington, sub-contractors for plumbing and the Elevator Supply & Repair Co., of New York, sub-contractors for stage equipment.

To Aid in the City Planning Movement in this country, the People's Institute, of New York, has arranged with Dr. Werner Hegemann, Secretary of the Greater Berlin Town Planning Commission, of Berlin, Germany, to spend a number of months in the United States. During this time Dr. Hegemann will place himself at the disposal of cities or civic organizations interested in city planning and will be ready to deliver addresses and make investigations and reports on city planning matters. Further information regarding Dr. Hegemann's experience in city planning work and the basis on which his services may be secured may be obtained from Frederic C. Howe, Managing Director, the People's Institute, 50 Madison Ave., New York City.

Improving the Quality of Cement—"We have followed the policy established last year of testing all cement used in our work. The tests are made in our own laboratory under the supervision and direction of our corps of engineers, and we believe it to be a valuable feature of our work. We exact the requirements established by the American Society for Testing Materials, and believe our practice in this respect has a salutary effect upon the cement companies. At any rate our test showed that the cement furnished almost invariably came up to or exceeded the standard required." (From 1911 report of the Board of County Road Commissioners of Wayne County, Detroit, Mich.)

Formula and Constants for Friction Loss in Dredge Discharge Pipes

By H. Berridge*

The possibilities of hydraulic dredges have greatly increased of late, owing to the development of the cutter head on the suction pipe, and clay and other compact materials are now handled by this type of machine. The transport of the dredged materials through the pipe line is an important factor in the question. The writer has investigated the figures given in the very complete reports of the Mississippi River Commission in the light of the pipe-friction formula given in Prof. W. C. Unwin's "Hydraulics."

Prof. Unwin says (p. 148): "At all velocities such as those with which the engineer has usually to deal, the flow of water in pipes is turbulent." The resistance originates in the irregularities in the surface of the pipe, producing eddy motions which fluid friction tends to still. "As the energy of an eddy is proportional to the square of its velocity and as this must have definite relation to the general velocity of translation of the stream, it is intelligible that the resistance varies nearly as the square of its velocity. In the strict sense there is no rational theory of turbulent motion but only empirical laws deduced from experiment" (p. 38).

The formula deduced by Prof. Unwin, after comparing a large number of experiments by different observers, is

$$\frac{h}{l} = \frac{m}{d^x} \cdot \frac{v^n}{2g}$$

where m is a constant depending on the surface of the pipe, x is a constant providing for variation in diameter of pipe (d), and n is a constant providing for variation in velocity of flow (v).

Converting the above into a logarithmic formula gives:

$$log\ h = n\ log\ v + log\ \frac{m}{d^x} + log\ \frac{l}{2g}$$

Plotting *log h* as abscissas and *log v* as ordinates gives a linear equation with a slope of n and an ordinate at the origin equal to

$$log\ \frac{m}{d^x} + log\ \frac{l}{2g}$$

Also, if m and x are constant, by plotting $log\ \frac{m}{d^x}$ as abscissas and *log d* as ordinates the slope is x, and the distance from the origin to where the line cuts the horizontal axis is *log m*.

Prof. Unwin excluded high velocities of flow from the scope of his work, as the pressures in such cases have to be measured by mercury gages, which present great difficulties, and his book is concerned with water supply only at low velocities.

In order to see if the formula were applicable to the velocities used for hydraulic dredging work, the writer used the diagrams showing the loss of head in the pipe lines of the dredges "Beta," "Gamma," "Delta," "Epsilon," "Zeta," "Iota," "Kappa" and "Flad," as given in the paper of F. B. Maltby, M. Am. Soc. C. E., read at the International Engineering Congress, 1904. The diameters of the discharge pipes on all the dredges varied only slightly. The writer thought it would be advantageous to plot $log\ i = log\ \frac{h}{l}$ instead of *log h* as abscissas of the graph.

In Table I the values of i and v are given. They are plotted in Diagram *I*. It will be seen that Prof. Unwin's value

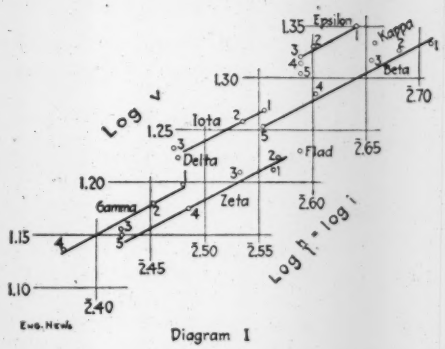


Diagram I

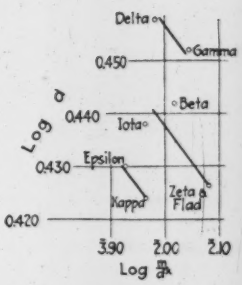


Diagram II

Diagrams for Determining Constants n and x in Unwin's Exponential Formula, from Observations on Friciton Loss in Discharge Pipes of Mississippi Dredges

TABLE I. CONSTANT m FOR DREDGE DISCHARGE PIPES, AND CHECK CALCULATION OF FRICTION LOSS

(From Diagram I, n = 1.87; Diagram II, x = 1.39)

No. of observation	Mean velocity of flow ft. per sec., v	Loss of head, ft. water, h	Length of pipe, ft., l	Slope $\frac{h}{l}=i$	Constant m		Recalculation of friction head* h
Dredge "Beta"							
1	21.6	33.4	650	0.0514	0.0454		33.5
2	21.3	31.0	..	0.0479	0.0458		32.7
3	20.8	29.4	..	0.0452	0.0451	0.0461	31.2
4	19.3	26.0	..	0.0400	0.0459		27.2
5	17.9	23.2	..	0.0358	0.0483		23.1
Dredge "Gamma"							
1	15.9	18.1	600	0.0302	0.0490		16.1
2	15.3	17.0	..	0.0283	0.0473		15.5
3	14.4	15.9	..	0.0264	0.0496	0.0484	13.9
4	13.7	14.1	..	0.0234	0.0476		12.8
Dredge "Delta"							
1	16.7	18.7	625	0.0298	0.0435	0.0435	19.1
Dredge "Epsilon"							
1	22.4	10.2	235	0.0435	0.0330		13.5
2	21.4	9.35	..	0.0398	0.0327		12.4
3	21.1	9.07	..	0.0386	0.0327	0.0335	12.1
4	20.9	9.07	..	0.0386	0.0333		11.9
5	20.1	9.07	..	0.0386	0.0359		11.0
Dredge "Zeta"							
1	16.3	22.1	605	0.0366	0.0495		19.4
2	16.7	35.6	962	0.0370	0.0478		33.2
3	16.2	32.9	..	0.0341	0.0467	0.0462	30.6
4	15.0	29.5	..	0.0306	0.0476		26.4
5	14.2	25.5	..	0.0265	0.0465		23.8
Dredge "Iota"							
1	18.6	16.5	460	0.0324	0.0395		18.2
2	18.3	15.8	..	0.0309	0.0390	0.0388	17.6
3	17.1	13.6	..	0.0266	0.0380		15.6
Dredge "Kappa"							
1	21.77	8.5	187	0.0455	0.0359	0.0359	10.3
Dredge "Flad"							
1	17.00	17.6	450	0.0382	0.0480	0.0480	15.6
					Average value	0.0425	

*Based on n = 1.87
x = 1.39
m = 0.0425

TABLE II. VALUES OF CONSTANT n FOR GOOSENECKS

No. of observation	l	h (corrected for gravity)	$\frac{h}{l}=i$	v	n
Dredge "Iota"					
1	4.27	4.07	0.955	17.15	3.16
2	4.27	6.35	1.48	18.3	3.23
3	4.27	7.17	1.68	18.7	3.24
Dredge "Kappa"					
1	4.15	10.87	2.86	21.77	3.22
Dredge "Flad"					
1	4.19	4.07	0.97	16.50	3.09
				Average,	3.19

*Port Engineer, Aden, Arabia.

of $n = 1.87$ for riveted iron pipe is very closely followed.

It should be noted that the values of h were obtained by mercury piezometers which showed considerable fluctuations.

The next step, finding x, does not give very good results in this case, as the range of d is so small. However, Prof. Unwin's value for riveted steel pipe, $x = 1.39$, gives a slope which is a fair mean of the observations.

Using this value of x, the value of m varies from 0.0359 to 0.0484 and has a mean of 0.0425, which approximates to Prof. Unwin's value for incrusted cast iron (0.0440). The usual value for riveted wrought iron is given as 0.0260, but it is easy to understand that the resistance offered by the flexible couplings and probably by some curvature of the pipes in the horizontal plane is responsible for the difference.

In order to show the results of using the values

$$n = 1.87$$
$$x = 1.39$$
$$m = 0.0425$$

the heads were re-calculated using these values for the constants in the formula. The results are shown in the last column of Table I, and they may be compared with the actual heads shown in the third column of the same table.

RESISTANCE OF REVERSE BENDS — In the dredges "Iota," "Kappa" and "Flad" a gooseneck or reverse bend was introduced at the stern of the vessel into the discharge-pipe line. This arrangement lifts the pipe above the water level and is advantageous for altering the alignment of the discharge. The diagrams, however, show a considerable drop in head due to the resistance of these bends.

Dealing with experiments on the flow of water in bends Prof. Unwin states that "the total resistance at a bend is made up of the skin resistance of a straight length of pipe of the same length as the bend, and an additional resistance due to the curvature which is not a shock resistance, but merely an augmentation of the skin friction." To the writer, however, this opinion hardly seems consistent with the theory previously enunciated. He submits that surface friction of pipe cannot be very different in a bend from that in straight pipe, but that possibly increased eddy action is produced by the alternation in direction of the stream.

The resistance heads of the reversed bends in the discharge pipes of these three dredges were therefore analyzed in the same way as the heads in the straight pipe, using the variation of the formula

$$n \log v = \log \frac{h}{l} - \log \frac{m}{d^x} + \log 2g$$

If from Table I $\frac{m}{d^x}$ is assumed to be that found for the straight pipe, $n \log v$ can be calculated, and consequently n, as in Table II. The constant n is found to have a mean value of 3.19. The diagrams showing the heads are not, however, quite clear as to the corresponding velocities.

Notes on the Water-Works of Victoria, B. C.

All the more important cities of the three Western provinces of Canada are enlarging their water-works to meet notable growths in population. Victoria, B. C., has recently contracted for a large additional water supply. It is completing the relining of a reservoir, has recently metered all consumers and is using Mannesmann steel tubes for distributing mains.

Victoria is supplied with water from both municipal and private works, the territory being divided. The city works supply outlying territory, and the same is true of the works owned by the Gold Stream Water Co. The municipal works are now delivering 4,000,000 to 5,000,000 Imp. gal. a day from Elk Lake, which is in excess of the safe capacity of the source. The water is filtered by means of open sand filters built many years ago. The supply is pumped.

NEW SUPPLY—A contract has been made with the Westholme Lumber Co., of Victoria, for a 38-mile gravity pipe line from Sooke Lake, and a 136,000,000 Imp. gal. storage reservoir. The contract price is $1,179,000. The contract calls for completion of the work by Jan. 1, 1914.

Sooke Lake has a drainage area of about 30 sq.mi., all of which the city proposes to acquire. The level of the lake is being raised some 12 ft. by a concrete dam. For its first 27 miles the new gravity conduit will be 42 in. in diameter and have a fall of only 1 ft. per 1000. This portion will be of reinforced concrete, with a 3-in. shell. The pipe will be made in sections, on the water front. The exact type has not yet been decided and is optional with the contractor.

The Humpback Reservoir, at the end of the flow-line conduit, will be formed by a low concrete dam and will give a head of 380 ft.

From the reservoir a 36-in. steel pressure pipe line will extend 11 miles to a 16,000,000-gal. reservoir in the city, already built. Ultimately it is expected that the Sooke Lake Dam will be raised to a total height of 50 ft., and that a second drainage area (Leach Lake) will be acquired, thus giving a total available daily supply of 100,000,000 Imp. gal. The rainfall on these drainage areas is said to be 70 in. a year.

RELINING A RESERVOIR—The 16,000,000 Imp. gal. reservoir already mentioned has just been relined at a cost of some $65,000. The reservoir was built only a few years ago and proved leaky. It was mostly in excavation, and largely in rock. The lining and floor were of concrete, were very thin in places, and portions of the concrete floor were not carried to solid rock.

In the relining, the floor was first covered with 5 in. of 1:2½:4½ concrete, on which was placed 1 in. of 1:1½ cement mortar. This floor was laid in blocks 20 ft. square, breaking joints with the original blocks of the same area. At intersections of the old and the new floor joints, the old joints were cleaned out for a distance of 1½ ft. each side of the new joints and grouted with cement mortar. Asphaltum expansion joints were used on the new work.

To reline the sidewalls of the reservoir, concrete slabs were used and care was taken not to permit the slabs to bond with old work. The wall lining slabs were in panels 20 ft. wide and 22 ft. high, 6 in. thick at the top and 11 in. thick at a point 3 ft. from the old floor, from which level a toe extended until it met the new 6-in. floor. The concrete for the side-wall slabs was 1:2:4.

MANNESMANN TUBE WATER MAINS—Mannesmann seamless steel tubes have been used for distributing mains at Victoria for the past two years. The Esquimault Water Co., as well as the city, uses these tubes. The prices paid by the city for the tubes delivered along the street trenches are as follows: 12-in., $1.59; 8-in., 72c.; 6-in., 52c.; 4-in., 29½c.; specials, 21c. per lb. The tubes come in 28-ft. lengths. They are coated with asphalt, wrapped with jute and again coated with asphalt. They are made in Swansea, England, under German patents.

WATER METERS—All services on the municipal water-works of Victoria are metered. Prior to 1908, some 300 to 400 meters a year were set. In the year named, authority to meter all services was secured. Trident meters were adopted. Notwithstanding the fact that all services are metered the water consumption averages 85 Imp. gal. or more per capita. This is due to the long, dry summers and the large areas of lawns and gardens in Victoria.

J. L. Raymur is water commissioner of Victoria. Wynn Meredith, San Francisco representative of Sanderson & Porter, New York City, is Consulting Engineer for the new supply, with Harry Hartwell as resident engineer. R. H. Thompson, of Seattle, was consulting engineer for the reservoir repairs, and A. E. Foreman, principal assistant city engineer, was in direct charge of the relining. C. H. Rust has been city engineer of Victoria since May, 1912.

The Widening of the Simplon Tunnel, projected some time ago, as noted in Engineering News, Mar. 7, 1912, p. 470, is not to be carried out, according to "The Engineer," of London. It is reported that instead a second gallery is to be driven, at a cost of about $7,000,000.

Letters to the Editor

An Attractive Letter Applying for a Position

Sir—I am sending you a copy of an application from a man whom I do not know, but it is in such excellent form and so different from the many applications we receive that it really seems worth while publishing.

The names and places have all been changed from those in the original letter.

CONSULTING ENGINEER.

New York, July 5, 1912.

Mr._____

City of New York.

Dear Sir:

Please grant me an interview in reference to filing an application for the business of transitman or draftsman.

Education,

Four years' civil engineering course at Blank University, graduating in 1911.

Experience,

Six months' highway construction work, as transitman with the A. B. C. Motor Parkway Co.

Three summers' varied field and office work in surveying at the university camp.

References,

Mr. A. B. Jones, Asst. Ch. Eng., A. B. C. Motor Parkway Co., Smithville, N. J.

Mr. M. N. Mathews, Res. Eng., A. B. C. Motor Parkway Co., Brownburg, N. J.

Prof. B. L. Hann, Dept. of Civil Engineering, Blank University.

Awaiting your kind reply,

Respectfully yours,

(sgd) _____

June 26, 1912.

Concrete in Sea Water

Sir—The writer has noted in your issue of July 4, 1912, p. 29, the letter from William B. MacKenzie, relative to his review of the papers on reinforced concrete in hydraulic works submitted to the International Navigation Congress. Mr. MacKenzie pretends to quote the writer as follows: "The objections to concrete in sea water are imaginary and must have arisen at a time when the subject was not so well understood as at present." The writer desires to point out that his paper contained no such statement. What he really said was as follows: "The conclusion seems justified that all of the objections that have been urged against the use of reinforced concrete as a material suitable for use in connection with hydraulic works are either imaginary, or can be overcome by practicable methods, and must have arisen at a time when the subject was not so well understood as at present."

While the other alleged quotation made from the writer's paper by Mr. MacKenzie has not been quite so completely altered, it has, nevertheless, been changed so as to imply a meaning which clearly does not pertain to the language used in the writer's paper. However, the writer is satisfied to refer to the papers reviewed for proof that concrete has been successfully used in permanent structures everywhere; this does not imply by any means that there have not also been failures in concrete structures everywhere just as there have been in structures made of any other building material when improperly or ignorantly used.

It may be worth while to point out that if the cases of disintegration to which Mr. MacKenzie refers are really due, as he apparently believes, to freezing and thawing and nothing else, it follows as an inevitable conclusion that it is only necessary to make the concrete impervious; freezing and thawing could then no more affect the concrete than the vitrified bricks shown in the illustration accompanying Mr. MacKenzie's letter. They stand, not because they are bricks, but because they are vitrified and practically impervious. If porous bricks were used, they would suffer in the same way as the concrete. The rate of increase of the damage would depend upon the porosity and strength of the bricks.

JOHN STEPHEN SEWELL.

Gantts Quarry, Ala., July 6, 1912.

Stresses Due to Peripheral Eccentricities of Circular

Sir—Jacob Friedland in his discussion of my paper read before the New England Water Works Association and reprinted in your issue of Apr. 25, 1911, on the stresses due to peripheral eccentricities of circular tanks, which discussion appeared in your issue of July 11, 1912, p. 73, has erred in applying to reinforced concrete a theory which in its entirety is correct only when applied to a tank with a homogeneous shell. The analysis, which is well stated, is correct for a steel tank, but all of it does not apply to the type of construction under discussion. The error that has been made is in assuming that in such a structure the bending moment due to the eccentricity in circular construction is the product of ring tension and the eccentricity measured from the steel reinforcement. His statement that the fiber stresses due to bending are only of secondary importance is true only for steel tanks. In such tanks there is sufficient flexibility in the shell to adapt itself to the true curve without over-straining the material. In reinforced-concrete tanks, on the other hand, the stiffness of wall is sufficient to prevent this to a very large extent.

The tank under discussion is a reinforced-concrete tank in which the reinforcement consists of circumferential steel bars arranged in a single row. It is impossible to construct such a tank in which the ring tension coincides with the reinforcement at every point. In a flexible steel shell a more or less complete adjustment can take place without overstressing the material of which the shell is made. In a reinforced-concrete shell this readjustment is prevented to a very large extent by the compressive resistance developed in the concrete, on the same side as the eccentricity. The bending moment developed in the shell from this eccentricity is measured by the product of ring tension and the distance from the neutral axis of the section to the line of action of ring tension instead of the distance from the center of the section to the line of action of ring tension, as stated by Mr. Friedland. The shifting of the neutral axis of the section in bending from its central position is due to the fact that ordinarily concrete is already stretched in tension an amount far above its elastic limit, and therefore can offer very little, if any, additional resistance to bending.

Computations show that secondary stresses due to the eccentricity will be considerable in all cases. In the tanks of small size, however, and those with comparatively thin walls, there is a considerable reduction in bending because of the flexibility of the shell. This rapidly decreases in the larger tanks with thicker side walls, the stiffness of the wall increasing as the cube of its thickness.

Although not stated in my paper reprinted in ENGINEERING NEWS, the eccentricities from the true circle are apt to increase with the diameter. As has also been pointed out, in my paper, it was not the intention of the writer to show with any degree of accuracy the variation of the ring tension in various sized tanks, but simply to bring to the attention of the profession the possible presence of high secondary stresses that may be developed due to irregularities in construction in concrete-steel tanks with a single row of circumferential reinforcement.

ALEXANDER POTTER.

114 Liberty St., New York City,
July 12, 1912.

Specifications for Railway Maps in California

Sir—My attention is called to an editorial in your issue of June 27, 1912, entitled "Specifications for Railway Maps," which appears to have been inspired by an order of the California Railroad Commission containing "Specifications which shall govern the preparation of alignment maps, station plats and profiles of railroads for filing with the Railroad Commission of California."

After commenting briefly on the scope and purpose of this order you state, "The specifications would seem to have been drafted largely on the basis of asking for everything which might be of any use whatever. A better and fairer basis would seem to be to require only what can reasonably be furnished. It does no good but rather harm to ask for impossibilities."

It would seem that it was the purpose of this statement to criticize the California Commission and to intimate that its methods of dealing with the railroads are unfair. If this is true, the accusation is a very unjust one. This Commission has never and does not now require "impossibilities." Modifications of the order to which you refer have been made in many cases where records have been lost or destroyed and it is not possible to furnish data in the form requested without undue trouble and expense.

As a matter of fact, the Commission intended that these specifications should be used as a guide when preparing maps and profiles of railroads for its use, and as indicating the form and scope in which it desired that data be furnished. Anyone familiar with the work of a Railroad Commission whose powers and duties are as extensive as the California Commission, will appreciate the necessity of having information presented in a uniform and systematic manner. It is advisable and helpful to the railroads as well, that some kind of specifications be provided, in order that records may be prepared in a manner that will be satisfactory. It is far from the truth to assert or intimate as you have done in this case that it is the intention of this Commission to be in any sense unfair with the railroads or to endeavor to impose burdens on them that are unreasonable.

I have always been impressed by the NEWS' sense of fairness, especially in its Editorial Department, but it seems that in this case, for some unaccountable reason, an over-anxious desire to criticize has resulted in a statement that is unjust to the parties concerned and which the facts do not warrant.

R. A. THOMPSON, Chief Engineer.
California R. R. Commission,
San Francisco, Calif., July 3, 1912.

[We give space with pleasure to our correspondent's letter, as it furnishes evidence that the "Specifications" referred to were intended by the Commission to be regarded rather as what the Master Car Builders' Association calls "Recommended Practice," instead of an official order. We have received other correspondence, however, which indicates that engineers of some of the railway lines in California viewed the specification in the same light as we did, and had become hostile to the Commission because they felt it was asking unreasonable things of them. We hope the above letter may pave the way to a better understanding between the parties.—ED.]

Early Advocacy of Peaked Street Crowns

Sir—I am reluctant to add to the voluminous matter relative to the crowns of streets, but I can not forbear a mild protest regarding the article appearing in your June 6 number, p. 1086.

When a writer without preface "proposes" a certain surface for street pavements the inference is that his proposition possesses originality. The curve proposed by Mr. Whinery is identical with that described by me in Staley's "Gillespie's Surveying," Art. 868, in 1897, and this shape of cross-section had been employed for some years in Albany's streets at that time, and continued to be so employed for years later. Certainly not less than 20 miles of streets were paved with this form of crown in Albany previous to 1900.

In the article in Staley's Gillespie, referred to above, I did not assume the credit of originality, though my amplifications regarding this particular form were original, as far as I know. My form of cross-section is identical with the proposed curve of Mr. Whinery. The circular arc form was criticized by Prof. Gillespie in his work, "Roads and Railroads," which appeared in 1847, and in my edition of 1853 he refers to the segment of a circle as the "usual, though improper, shape." In the ninth edition of the "Encyclopedia Britannica," Thomas Codrington remarks:

> Telford (1754-1834) used a cross-section differing slightly from an arc of a circle in being more convex in the middle than at the sides. . . . An arc of a circle is often used, and is a good form, but on the whole a curve more convex at the center than toward the sides is the best. The rise in the curve from the sides to the center need not exceed one-fortieth of the width, and one-sixteenth is generally enough on well kept roads, and if seven-eighths of the total rise are given at one-fourth of the distance from the center to the sides, and five-eighths at half that distance, a curve of suitable form will be obtained.

It is worthy of remark that this recommendation of Codrington forms the basis of my development in the article in Staley's Gillespie, and is precisely what Mr. Whinery now proposes.

I generally found the ratio of $^1/_{72}$ of the width to be the most convenient and useful one, on account of its easy relations between feet and inches and because it seemed to give an ample height of crown. In forming the sand-cushion to a pavement of blocks laid on concrete where a template is used to strike the surface of the sand, a close adherence to the theoretical form is readily obtained. In general, ordinates measured down from a stretched line drawn from curb to curb will be found most convenient and it was the practice of the writer to furnish both contractor and inspector with diagrams showing these downward measured ordinates at the crown, quarters and eighths.

I would refer anyone interested to the amplification of the general subject in the work of Staley referred to, and will append a short table which may prove useful to some of your readers and which has never been published hitherto. It gives the ordinates, regarding the crown as unity, and also the rates of fall in percentages under the assumption of a crown which is $^1/_{72}$ of the width of the street and also of a crown which is $^1/_{60}$ of the width of the street; both of these are for the usual, improper, segmental form and for the form adapted from Codrington by me. The percentage rates of fall, of course, assume the two gutters as being of the same level; if they are not, the rates may be changed in reference to their known difference of heights.

Half section divided into twelfths	Ordinates for Circular Arc	Ordinates for Preferred intermediate form	Rates of fall, per cent. Crown $^1/_{60}$ W. Circular arc	Crown $^1/_{60}$ W. Intermediate	Crown $^1/_{72}$ W. Circular arc	Crown $^1/_{72}$ W. Intermediate
			%	%	%	%
0	0.000	0.000	4.80	3.63	5.33	4.02
1	.160	.121	4.38	3.45	4.87	3.83
2	.306	.236	3.96	3.24	4.40	3.60
3	.438	.344	3.51	3.00	3.93	3.33
4	.556	.444	3.12	2.82	3.47	3.13
5	.660	.538	2.70	2.61	3.00	2.90
6	.750	.635	2.31	2.40	2.57	2.67
7	.827	.705	1.86	2.19	2.07	2.43
8	.889	.778	1.47	1.98	1.63	2.20
9	.938	.844	1.02	1.77	1.13	1.97
10	.972	.903	0.63	1.56	0.70	1.73
11	.993	.955	0.21	1.35	0.23	1.50
12	1.0000	1.000				

If W = width of street, C = crown, then the ratio $\frac{W}{C} = n$ and the radius of the circular arc is $= \frac{nW}{8} = \frac{W^2}{8C}$.

The radius of the "intermediate" curve is twice the above $= \frac{nW}{4} = \frac{W^2}{4C}$.

HORACE ANDREWS.
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Contents

	Page
*Effect of Storms on a Lake Breakwater; L. W. Goddard	91
*A High-Power Passenger Locomotive	93
A Comparison of Gas and Electric Power for Drawbridge Swinging	98
*Small Vertical-Lift Drawbridges	99
*Northern Pacific Ry. Station, Tacoma	102
Casting Pure Copper by the Use of Boron Suboxide; R. D. Thompson	105
Shopwork for Engineering Students; Winslow H. Herschel	106
*Bleeding Steam from Receivers of Triple Expansion Engines for Heating Feed Water; Geo. M. Peek	110
*The Service Equipment of a Combined Theater and Office Building; W. A. Ehlers	112
*Formula and Constants for Friction Loss in Dredge Discharge Pipes; H. Berridge	117
Notes on the Water Works of Victoria, B. C.	118
LETTERS TO THE EDITOR: An Attractive Letter Applying for a Position; "Consulting Engineer"—Concrete in Sea Water; John Stephen Sewell—Stresses Due to Peripheral Eccentricities of Circular Tanks; Alexander Potter—Specifications for Railway Maps in California; R. A. Thompson—Early Advocacy of Peaked Street-Crown; Horace Andrews.	119
EDITORIAL: New Standards for Pipe Flanges—Feed Water Heating with Live Steam—Power for Swinging Drawbridges—The Economical Limitations to the Size of Locomotives and Weight of Trains.	121
*The Regina, Sask., Tornado	124
ENGINEERING NEWS OF THE WEEK	126
PERSONALS	127
ENGINEERING SOCIETIES	128
ENGINEERING LITERATURE	129

*Illustrated.

Engineering News

New Standards for Pipe Flanges

The importance of the work recently done by a committee of the American Society of Mechanical Engineers in reporting new standards for extra-heavy pipe fittings in sizes above 9 in. in diameter was attested at a hearing which took place at Washington, D. C., last month, before the Bureau of Yards and Docks of the Navy. A number of the principal manufacturers of flanged fittings object to the new standards on the ground of the expense that would be involved in making the change to the new dimensions. In defending the new standards, H. G. Stott, Chief Engineer of the Interborough Rapid Transit Co., of New York City, showed by means of charts representing temperature stresses in pipe lines that whereas the factor of safety in the ordinary pipe line from stresses due to internal pressure is from 16 to 20, the factor of safety in the bolts at the flange joints is 2 or less. It was these considerations which had governed the committee of the American Society of Mechanical Engineers and of the National Association of Master Steam & Hot Water Fitters in framing the new standards for extra-heavy piping of large dimensions. It is stated that in view of the showing made at the hearing by the representatives of these two societies, the manufacturers are likely to concede the importance of the new standard and conform to specifications based upon them.

Feed Water Heating with Live Steam

Elsewhere in this issue we report some tests recently made at the St. Louis water-works on feed-water heaters attached to high-duty pumping engines and taking steam from the intermediate receivers. The result of the addition of these heaters to an engine was to increase its duty by about 9%. In addition to this, there were the very practical advantages that the boilers were fed with water heated to the boiler temperature, thereby reducing the temperature stresses in the boilers and that solid matter deposited as a result of the heating was deposited in the feed-water heaters rather than on the boiler tubes. We are aware that it is not by any means novel to use feed-water heaters* in connection with multiple-expansion pumping engines; but the cases where this system has been put into practice are as yet so few that it is well worth calling special attention to and putting on record the results of accurate tests made to determine the economy gained by the attachment.

At first sight, using live steam to heat feed water sounds a good deal like "lifting one's self by one's boot-straps" (a proverb which harks back to the days when such things as boots and boot-straps were still worn). There is, of course, no doubt that to take a certain number of heat units in the form of live steam out of a boiler, use it to raise the temperature of feed water and force it back into the boiler again, is to put back exactly as much heat into the boiler as is taken out, less any loss from radiation. The advantage of live steam feed-water heating, therefore, must rest solely on the advantage gained from reduction of the temperature stresses in the boiler, from purifying the feed water to a certain extent from solid matter before it enters the boiler and from the better circulation secured in the boiler when all the heating surface is generating steam and giving off steam bubbles to promote circulation, and none of it is simply raising the temperature of the inclosed water. Whether these advantages justify the use of live steam feed-water heaters is a question to be determined in each case by the particular conditions prevailing.

Exhaust steam feed-water heating rests on a different basis. Here heat is taken which would otherwise be thrown away (in the case of a non-condensing engine) and is used to raise the temperature of the feed water. Evidently all the heat saved in this way is so much to the good. Also evidently the limits of effective feed-water heating where exhaust steam is used stand at 212°. Heating feed water by the steam taken from the receivers between the cylinders of a triple-expansion engine stands between live steam feed-water heating and exhaust steam feed-water heating with respect to economy. The steam used for heating has already done some of its work and if it were not drawn out of the receiver would do still more work in the intermediate or the low-pressure cylinders. Both the theoretical computations and the actual test made at St. Louis, however, showed that steam so used gives a net increase in the economy of the plant over the result when the engine is operated without the feed-water heating. The criticism may be made, perhaps, that a still better plan of heating feed water to the boiler temperature is to pass it through an economizer and utilize the heat which would otherwise be wasted up the chim-

*See Eng. News, Sept. 27, 1900, p. 212.

ney. Local conditions, however, may not always permit this and the drawings accompanying the article elsewhere published show that the live steam feedwater heater applied to the receivers makes a compact and simple arrangement and is apparently a very economical way to increase by about 10% the duty of a multiple-expansion pumping engine.

Power for Swinging Drawbridges

We publish on another page of this issue the results of tests made at the swing span of the International Bridge at Black Rock, N. Y., to determine the amount of power required for operation and the relative cost of the power when supplied by a 100-hp. gas engine using natural gas at 30c. per 1000 cu.ft., and when supplied by a motor-generator set using current from a power station at Niagara Falls.

As an offhand opinion, it would doubtless be said that with the cheap current furnished from Niagara Falls, the gas engine would have no chance in the competition. At the prices charged, however, for the comparatively small amount of current used, the Niagara Falls power was not particularly cheap. Figuring in the loss in the storage battery, its cost was 3.2c. per kw.-hr. Compared with this, the cost of the current generated by the gas-engine set through the storage battery, including the cost for gas, water, lubricating oil and attendance alone, amounted to only 1.8c. per kw. However, when a fair allowance is made for interest, depreciation and repairs on the gas-engine generating set, the cost per kilowatt of the current which it supplies is nearly three times the cost shown from the daily expense sheet alone. When, in order to make the comparison fair, the same items of interest, depreciation and repairs are added to the expense account of the motor-generator set using Niagara Falls current, it is found that the two systems of power production stand about on an equal footing as respects cost per unit.

We need hardly say, however, that these figures tell only a small part of the story concerning the problem of power for drawbridge operation. The foremost question with the engineer is not what number of cents or dollars the power costs which is required to swing the bridge and move the necessary auxiliary machinery, but what is the *reliability* of the equipment? The cost of an hour's delay in the operation of an important drawbridge because of deranged machinery may mean a greater loss than the total cost of the power required to operate it for a dozen years. In the case of the Black Rock bridge the double source of power supply was not put in with any idea that one power was or might be cheaper than the other, but to have two independent sources of power available, so that if current from the Niagara Falls station were cut off for any reason, the bridge could be operated with its own power generated on the spot. On the other hand, if it were the usual practice to use the gas engine for operation, Niagara current would always be available as a reserve.

There are, of course, comparatively few locations where the gas engine proper is available for operating drawbridges except where a bridge is located in or near a city so that a municipal gas supply can be drawn upon. Lacking this, the only resource, if an internal-combustion engine is to be installed, is the gasoline engine; and the handling and storage of gasoline in and around an important bridge structure, where it is exposed to more or less risk from flying sparks, is always more or less objectionable. A fire in the bridge-operator's cabin may not do any serious damage to the structure, but it may obstruct for a considerable time the operation of the draw. Operation by electric current from electric-railway or power-distribution systems is also attendant with more or less risk of interruption in the current supply. In the case of bridges of moderate size, the problem is comparatively easy because in case of break-down of the power machinery, hand-power can be resorted to for turning with comparatively little delay. For bridges of very large size, however, it is undoubtedly good practice to have as many sources of power as possible available for use in an emergency; and where both electric current and an independent source of power can be furnished, it is well worth the extra cost.

The Economical Limitations to the Size of Locomotives and Weight of Trains

We reviewed in these columns last week recent progress in American locomotive design as evidenced by typical locomotives built during the past year. We there stated, what is well known to everyone familiar with railway matters, that the endeavor of locomotive designers in response to the demand of locomotive purchasers, has long been to build the biggest and most powerful machines which the limitations of clearance, gage of track and strength of materials will permit. Road locomotives are now built capable of exerting a pull of over 50,000 lb. and pusher locomotives with over 100,000 lb. tractive power.

It seems to us that it is time to call a halt and inquire whether we have not reached a point in railway operation where we will lose more than we will gain by further increase in the power of locomotives and the weight of trains. For it is only as a means of saving money that railway managers are demanding big locomotives. It is because it has come to be an accepted part of the creed of every railway manager that the figure representing the average weight of freight trains hauled over a road is an index of the economy with which its business is conducted. It is because the pseudo experts of the Wall Street financial world have come to regard this figure as telling the whole story concerning the ability of the manager in charge of a railway, that every railway officer is demanding larger locomotives, capable of hauling longer trains.

There is, of course, no doubt whatever that the big locomotive and the long train have worked the most marvelous revolution in American railway practice that has ever taken place on the railways of any country. It is these two factors most of all which enable American railways, while paying their employees more than double the wages paid in Europe, to haul freight at a ton-mile cost far below that of any other country in the world.

ENGINEERING NEWS may, perhaps, speak with some authority upon this matter, for it played a not unimportant part in bringing about this revolution. The late A. M. Wellington, in the years of his activity, was a prophet who in season and out of season, in his monumental treatise on railway location and in the columns of this journal, preached the doctrine of large train loads as the way to economic railway operation and financial salvation. Many among our older readers may still remember the force and emphasis with which he urged the introduction twenty-five years ago of automatic couplers and air brakes, not alone because of their value as safety appliances but because their adoption was essential to the increase in train length and weight which he and other leading experts in railway economics recognized at that time was essential to the development of the American railway industry.

More than that, it was essential to the prosperity and even to the settlement of large sections of the United States, where a long rail haul was necessary to enable the products to reach a market, that freight should be hauled at a cost per ton-mile far below anything which was dreamed of or possible with the small-capacity cars, light locomotives and short trains of the 70's. There were many years in which the railway world gave little heed to the preaching of economic prophets like Wellington. It was not till a few progressive companies led the way and demonstrated the great saving to be made by long trains and large-capacity cars that the railways generally were led to take up the new departure.

All this, of course, is past history, of practical interest now only as it sheds light on the problems of the present and future. We have alluded to it here only to show that we are dealing with this matter from a broad point of view. We are fully aware of the enormous economic revolution which has been wrought in the past thirty years through increase in rolling-stock capacity and train loads. It is with full recognition of the great advantages gained in the past that we raise the question whether we have not now reached the limit, or indeed passed beyond it? Whether any gains by further increase in size of locomotives and length of trains will not be more than counterbalanced by resulting losses?

Let us first inquire what saving in operating expenses a railway makes by increasing its train loads, or rather let us say by increasing them over the loads which are now standard on most railways of heavy traffic. The chief saving, of course, is in the wages of engine crews and train crews. Admittedly these constitute a very heavy item in railway operating expenses, in round numbers approximately 12½% or one-eighth of the total, taking the average of the large railway systems of the United States.

There are certain forces coming into operation, however, which are likely to change past conditions, and cause further increases in train length to make necessary a corresponding increase in trainmen's wages. One of these forces is the legislation already enacted in some states and being pushed in others requiring "full train crews" on all trains. Another force is the pressure being exerted by railway labor organizations to make the pay of engine crews vary with the power of the locomotive. During the present month railway firemen have demanded that two firemen be employed on locomotives above a certain size. These are factors which cannot be ignored or lightly passed over. Before we go farther in the design of huger locomotives to haul longer trains, it must be seriously inquired whether the gain made by such changes in the past is not going to be neutralized under present-day conditions by the attitude of railway labor.

It may be said, however, that there are other economic advantages in increasing the weight of trains beside the saving in wages of train crews. The cost of dispatching and of controlling a train by signals, etc., is the same whether it is long or short. It is said, too, that the capacity of a road is measured by the length of trains which can be operated over it.

There is an offsetting factor, however, to all these economies. Train dispatchers, as well as train crews, have more trouble in getting very long trains over the road than trains of normal length. The capacity of a road, too, is more likely to be diminished than increased when the train length becomes so great as to interfere with the prompt and efficient handling of trains upon their arrival at or departure from terminals or their stopping and starting at sidings *en route*.

It is sometimes argued that there is a saving in locomotive fuel in hauling very long trains, but the limit of economy in this direction was long ago passed. At the present day locomotives are worked far beyond the point of fuel economy and the locomotive firebox has become a machine not for the economical burning of coal but for extracting the most heat possible per second from all the coal the fireman can shovel into it regardless of how much is blown out of the stack unconsumed and spread over the right-of-way.

So much for the savings to be made, or rather to be hoped for, from further increase in train length. Let us now inquire what further increase of train length will cost in the way of added operating expenses. The added expense which appeals with greatest force to engineers is doubtless that due to the wear and tear of heavy locomotives and long trains on the permanent way. Heavy locomotives mean not only long trains but fast trains; and it is the combination of heavy wheel loads and high speed that works woful destruction on railway track. The cost of maintenance of way on American railways amounts to one-fifth of the total operating expenses. The cost of ties alone is over 3% of the total operating expenses and this cost is steadily increasing year by year, being now in excess of $60,000,000 per annum and certain to greatly increase in the near future with the rapid exhaustion of the timber supply. The tie preservative processes cannot help very much, for under the stress of heavy traffic, ties are worn out instead of living out their natural life.

We need do little more than allude to the serious problem presented by rail breakage and rail wear under the stress of the terrific loads now imposed by present rolling stock further than to say that as far as we are aware neither the railway managers, the railway engineers nor the rail manufacturers quite know as yet what they are going to do about it. If we must be obliged to go to 125-lb. rails, rolled of openhearth steel, perhaps with some expensive alloy or special heat treatment, at least for the rails used on curves, where heavy wear comes—if this is the price that must be paid to enable running of heavier locomotives and longer trains, then manifestly this expense ought to be set down in the computation when we are figuring what net gain is to be made by further advance in this direction.

Doubtless the proposition of further increase in rolling-stock weights will arouse strongest opposition in the engineering department because of the effect on bridges and culverts. From the economic point of view, however, this is far from being the most important consideration. Large as is the outlay on such structures on American railways, it is after all hardly half the annual outlay for tie renewals. Further, on the large majority of bridge structures it does not add any large percentage to the cost to build them strong enough in the first place to carry the heaviest locomotive. The advantage gained in stability and long life by such proportioning is well worth the additional cost.

What *is* extremely important, however, from the economic point of view, is the effect of long, fast trains and heavy locomotives on the cost of track maintenance. This item now stands at over $140,000,000 per annum on American railways. Every engineer familiar with maintenance-of-way work knows that it is the wear and tear of the heavy locomotive and high-speed train that require track labor to maintain line and surface. Let us not forget, too, that railways cannot expect in the future to be able to obtain track labor at the prices which have prevailed in the past. The increased cost of living, if nothing else, will make it necessary to pay the man with the pick more money than what would have been deemed high wages a few years ago. Again, higher wages must be paid such workmen because other employers of labor are competing to hire them. Higher prices for farm products divert track workers to the farm. Besides these, market conditions tending to compel higher wages, the influence of the labor union is felt here as in every other department of the transportation industry. If, then, heavy locomotives and long and high-speed trains, mean increased expense in repairs to track, this is another item to offset the alleged economies.

Probably the most serious item of all, however, to be considered in connection with increased weight of locomotives and trains is the item of rolling-stock repairs. The *Railway and Engineering Review* has recently been running a series of articles headed: "What is happening to the railway freight car; the growing cost of maintenance of equipment." It has published great numbers of photographs taken on "Bad order tracks," all showing the damage which is being done to freight equipment cars by their handling in long trains by powerful locomotives.

Of course, this damage is only what is to be expected. You cannot transmit a hauling power of 25 tons and upward through a long freight train without exerting enormous stresses upon draft-gear, couplers, car sills, car floors, etc. It is not the mere static stress of the locomotive's push or pull which does the damage. In a long freight train, the locomotive's push or pull is transmitted in a series of waves and shocks through the length of the train, especially where the train is hauled over a broken profile through dips and over humps. Improved

draft gear and better brakes have reduced the severity of these shocks in long trains so as to make the hauling of long trains possible, but they have by no means eliminated them. It is these shocks in movement over the road and in the shunting in yards which is working serious damage to car superstructures, the results of which are seen in bulged ends, leaky roofs and serious injury to the lading of cars and large claims for damages.

The last statistics available give the freight-car equipment of the United States in round numbers at approximately 2,100,000 cars. During the fiscal year ending June 30, 1910, the cost of repairs, renewals and depreciation on these cars was about $181,000,000. In the same year these cars made an average annual mileage, loaded and empty, of about 9000 miles, so that the average cost of freight-car maintenance was in the neighborhood of 1c. per mile run. It is not necessary to quote statistics, however, to prove the fact, which is well known to every railway-car department, that a large part of the cost of freight-car repairs is due to the damage done by the use of high-power locomotives.

This does not complete by any means the list of items of railway operating expenses which are increased as a result of the operation of abnormally heavy locomotives and trains. In yard work, for example, it must not be forgotten that in order to move a very long train over the road, a great deal of work must be done in the yards sorting cars and putting the train in shape to make its long run without stopping for re-sorting. We have not mentioned, either, the fact that a wreck with a long train is very much more serious than with a short one, nor have we referred to the well known fact that a locomotive loaded nearly to the limit of its hauling power is very much more apt to fall behind its schedule and cause delays and obstruction to traffic than will be the case if it has a fair margin of capacity above the load placed behind it.

Reference might also be made to the fact that in the craze for high power in locomotives, fuel economy, and refinements in design which lessen the cost of maintenance have been largely lost sight of. There are numerous directions in which the locomotive is susceptible of great improvement by intelligent and scientific design, and economies gained in such a manner are not subject to the numerous heavy offsets which we have shown above are certain to attend further increases in the size of locomotives and trains.

The Tornado at Regina, Saskatchewan

A tornado of rather limited area but great intensity struck the center of the business and residence section of Regina, Sask., about 5 o'clock in the afternoon of Sunday, June 30, and wrecked about 50 blocks of buildings, killed some 28 persons and caused a total damage estimated at $4,000,000. The storm came at the end of a rather hot and sultry day and was first noticed as two heavy black clouds approaching the city from the south and the southwest. The two clouds came together with destructive effect at the public park in the southern part of the city and tore a three-block wide swath through the built-up section for a distance of some 14 blocks, practically destroying everything above the ground in that area.

The accompanying views have been sent us by C. A. P. Turner, of Minneapolis, Minn., who was at Regina shortly after the tornado, and Edgar I. Wenger, an engineer of Regina. Figs. 1 and 2 show the wreckage in the yards of the Canadian Pacific Ry., which were immediately in the path of the storm. Fig. 1 is a view of the wrecked engine house; it will be noted that the concrete in some places has been ripped from the angle-iron brackets it originally incased. Fig. 2 is the wreckage in the midst of the grain-elevator section of the yards; only one elevator remained standing after the tornado passed. Mr. Wenger, in commenting upon the force of the storm in the yards, writes: "A freight car was lifted bodily off its trucks, blown over the freight shed and against the cornice of a warehouse, a distance of approximately 300 ft. The height of this cornice from the ground was about 30 ft."

Figs. 3 and 4 are typical views of the effect of the storm on the frame and other light dwellings, which were either overturned or completely shattered. The effect on the more stable buildings is described by Mr. Turner, as follows:

THE ROUNDHOUSE

THE GRAIN ELEVATORS

FIGS. 1 AND 2. CANADIAN PACIFIC RAILWAY YARD IN PATH OF THE STORM

In general the damage is quite similar to that of the storm of Aug. 20, 1905, in Minneapolis and St. Paul. The wreckage is quite complete in the lighter class of buildings. Two churches, which were wrecked, one of which is shown in Fig. 5, illustrate the destruction by the explosive or unbalanced pressure of the air in the building when the external pressure is reduced by the storm. The windows of one church are completely taken out, while in the other the roof and gable walls are completely demolished. The fairly substantial business building shown in Fig. 6, is considerably damaged, all windows having been broken and galvanized-iron cornice badly wrecked. The reinforced-concrete structures in the city escaped with the least damage, though in comparing the different buildings it is, of course, difficult to state whether those which es-

FIGS. 3 AND 4. DWELLING HOUSES WHICH WERE DESTROYED

caped were subjected to the same conditions as those which were wrecked.

The writer has seen no evidence in such data as he has secured regarding the storm which would indicate that the modern well framed building of reinforced concrete or structural steel would be demolished by a storm of this character, although from the evidence at hand it is apparent that windows and the contents of the building would be

FIG. 5. CHURCH, WITH INTERIOR COMPLETELY WRECKED

FIG. 6. OFFICE BUILDING WITH WINDOWS BLOWN OUTWARD

liable to serious damage. The church buildings which suffered so severely are not braced by floors as is the ordinary business block.

A Tornado similar to that which struck Regina, but much less severe, hit Grand Rapids, Mich., on July 13, and caused considerable damage to property, though fortunately no one was killed. The principal structure damaged was a base-ball grandstand.

Notes on Clay Packing for Canal Lining

In the last few years a large amount of clay lining has been put in on the summit level of the new Berlin-Stettin ship canal. Two general methods of applying the clay were worked out: (1) putting it on in mass and rolling down successive layers, and (2) forming the clay into bricks which are then laid by hand and rammed down. On the canal bottom, and on normal parts of the side slopes, the clay is put on by the first method. To carry this out on the slope of the banks, the clay layers are put on in narrow horizontal strips forming a series of offsets or steps applied and rolled successively. In three years over 600,000 cu.yd. of clay packing have been put on by this method on the Berlin-Stettin canal. The following notes on the methods of applying this clay lining are abstracted from an article in *Zentralblatt der Bauverwaltung* of June 22, 1912.

The steam rollers used are generally of 5-ton weight, of the tandem type. The pivoted head of the front axle fork must not have too great a range of motion, and in the rollers as purchased the fork was blocked by the operator in order to limit the motion, so as to make the machine easier to steer and less likely to settle to one side when passing around a soft spot.

Clay is dug at the pits by contract. The material is taken out by bucket dredges. It is obtained in moderately dry condition (somewhat crumbly), transported to the canal in small dump cars, and dumped to form a layer about 8 in. thick. This layer is then rolled by the steam roller to a thickness of about 6 in., requiring six to eight trips of the roller. On the bank the strips of packing are generally run at a slight angle to the canal, running from top to foot of slope with a grade of 1 or 2%, on which the roller operates.

The clay was found to work best in the condition of moisture as dug. If too dry the material required to be moistened in depositing, in order to knead together well under the roller. If not thoroughly kneaded to eliminate air bubbles from between the clay particles, water can attack the banks.* When too moist, it squeezes out under the roller, and a dry layer must be applied over it and worked down with a horse roller as a preliminary to steam rolling.

Rolling cannot be done in rainy weather, as the moist clay sticks to the rollers and also becomes so plastic that the roller sinks in and is unable to advance. Ribbed rolls were tried, but they often produced tears in the course being rolled. Smooth rolls are preferred.

The clay layer must be covered with coarse granular material or gravel as soon as possible after completion, chiefly for protection against drying and checking. When this protecting layer is not put on promptly the sun is apt to produce cracks, which, however, go through the upper course only, provided this is not less than 4 in. thick, the courses below being protected from the sun's action by the upper course. To prevent cracking where the gravel cover could

*The following experiment is cited in illustration: If a small piece of pure clay is thoroughly dried it will readily dissolve or disintegrate in water to a thin state, while if first moistened and well kneaded it will keep its shape in water and will not disintegrate. The author attributes this to the fact that in the dried clay water entering into the pores between the clay particles causes a slight expansion of the individual clay particles which is sufficient to break the cohesion of the mass and cause it to dissolve or disintegrate.

not be applied immediately, the practice was adopted of covering the top layer with a 2-in. layer of rather dry clay (granular), which prevented cracking of the rolled clay below.

Clay packing of undried brick was applied at short bends, at bridge abutments, and at other special points. The bricks were formed at the pit, where a plant of about 150 cu.yd. per day capacity was installed, comprising a mill and a brick press. The bricks were laid up in close courses and then rammed to make a tight layer. Various difficulties arose in this work, such as the impossibility of producing brick of uniform plasticity, the difficulty of getting perfectly tight joints, and the liability of shrinkage and opening of joints of the top layer in drying. On account of the resulting troubles this type of packing was avoided as far as possible.

The cost of the work varied from 60 cts. to $1 per cu.yd. for the rolled work, to $1.50 for the packed work. The clay pits, however, were situated very favorably, and the cost of the clay delivered at the canal was unusually low. Ordinarily the packing is to be estimated at 50% to 100% higher.

Notes from Engineering Schools

IOWA STATE COLLEGE—A directory of graduates of the Division of Engineering in this Institution has just been published, in which there is given, for each graduate, his complete professional record from his graduation to the present time. While most engineering schools publish annual directories of their graduates and in some larger institutions single classes have published complete records of their members, it is very rare for an engineering school to publish the life history of the men who have gone out from it.

The last few pages of the book are devoted to statistics of the engineering alumni, and their average annual earnings since graduation. The statistics are based on 943 graduates leaving the institution between 1878 and 1910, of which 522 sent reports which were included in the tabulation. It appears from the tables that during the past ten years the graduates have taken positions on leaving college at which they received average salaries varying from $625 to $850 per year. After five to eight years' experience, the average income increases to from $1500 to $2000.

UNIVERSITY OF ILLINOIS—Bulletin No. 34 of this university describes the graduate work in engineering which is being pursued there. During the year 1911-12 the university had about 40 graduate engineering students. The pamphlet describes the class of work undertaken by these students, and the aim of the faculty in planning the courses of study, and sets forth the benefits which are expected to accrue to students pursuing these courses.

A Cloudburst at Denver, Colo., July 14, ruined property to a value of $1,500,000, and left 600 persons homeless. According to press reports, the crest of the flood, which entered the city along the course of Cherry Creek, was preceded by a storm with a wind velocity of about 48 mi. per hr., beginning at 3 p.m. In the two hours of heavy rainfall, streets were flooded, street railway traffic stopped and many miles of roadway destroyed. Then came a four-hour respite during which the street cars were able to resume operation. At 9:30 p.m., warning of the coming flood was received at the city hall, and within 30 minutes the "wall of water," many feet deep, swept into the city along Cherry Creek, which passes within five blocks of the city hall. The railway yards at the Union Station were flooded deep enough to put out the fires in locomotives. Several bridges and hundreds of small dwellings were carried away.

Concrete Chimney Failure—On June 2 a high wind demolished a 175-ft. reinforced-concrete chimney belonging to the Pennsylvania Cement Co., Bath, Penn. Three men were killed in the accident. The chimney was built about five years ago, being completed in May, 1907. It was 8 ft. in diameter outside in the lower portion, having an offset about ⅜ of the height above the base, the section being reduced in the upper part. The break occurred a short distance above this offset. The upper section was blown sideways and its end broke through the roof of a concrete boiler house 30 ft. away. The fallen portion then broke into small pieces. The boiler house was seriously damaged and three men in it were killed. It is stated by the officials of the Pennsylvania Cement Co. that there was trouble during the construction of the chimney because of the methods used. A part of the upper portion of the stack was built during freezing weather and subsequently the remaining portion of the height was built in the spring of 1907. The upper part of the chimney was slightly out of plumb, presumably as a consequence of the concreting in freezing weather. It is also stated that the concrete was put in as a dry mixture (for a fuller account with sketches of the chimney before failure see "Power," July 9, 1912, p. 41).

The Rear Collision, near Corning, N. Y., July 4, on the Delaware, Lackawanna & Western R.R., was due, as noted in our last week's issue, to the express engineer's failure to observe signals. He ran by a distant signal, a fusee lit by a rear flagman and a home signal, the three signals covering nearly a mile of track. Schroeder, the engineer, who survived the accident, has recently testified that he failed to see the signals for the reason that he was trying to repair one of the locomotive injectors. According to his statement, both injectors were out of order. He testified further that he had made the round of the Corning saloons on the evening before the wreck, but had taken only two glasses of gin "as medicine," together with a number of glasses of mineral water.

Water Meters are to be gradually installed in Schenectady, N. Y., to prevent a daily waste estimated at 5,000,000 gal., according to a statement made to a local newspaper by F. W. Bently, superintendent of the water-works. Schenectady has a population of about [illegible] and uses an average of 12,000,000 gal. daily, pumped from artesian wells in the town of Rotterdam, north of Schenectady. This is an average daily consumption of 165 gal. per capita. The proposed saving in water is expected not only to minimize pumping costs, but also reduce the size of the sewage-disposal plant, which the city expects the state authorities will order it to build within the next few years.

The Block-signal Equipment, on the line of the Delaware, Lackawanna & Western R.R., near Corning, N. Y., where the rear collision of July 4, took place, is stated to have automatic signals of the semaphore type instead of the banjo type, as stated in our last issue. The signal used is the Union Switch & Signal Co.'s Style "B," two-arm home and distant semaphore motor signal.

A Rear Collision on a line equipped with block signals occurred on the Chicago, Burlington & Quincy R.R., at about 6:45 a.m., July 14, at Western Springs, Ill., 15 miles from Chicago. The line here is double track, with manually-operated block signals. An express train (the Overland Limited) had been stopped by the signal at this place, but actually ran about 850 ft. beyond the station before coming to a stop (according to a statement issued by the railway). Nine minutes later it was struck by a fast mail train, which also passed the "stop" signal, but the engineman (who was killed) did not see or heed the signal. The rear flagman of the first train claims to have gone back 1125 ft. and placed torpedoes as required by the rules, but the statement above mentioned shows some doubt on this. The fireman of the second train is reported to state that the collision occurred almost immediately after the explosion of the torpedoes, while the mail clerks on this train are said not to have noticed any torpedoes or any application of the brakes. The train's speed was not over 60 miles. The morning was rather foggy, so that the block signal could not have been seen in time to prevent the collision. There was no distant signal. The responsibility for the accident seems to lie between the flagman of the first train and the engineman (killed) of the second train. Of the 13 persons killed, 12 were in the rear sleeping car of the first train, and most of the 16 injured were in the next car, which was overturned.

An Automatic Stop System for railways, invented by A. R. Angus, of Sydney, Australia, is being demonstrated in England on a short stretch of abandoned railway at Watchet, in Somerset. A portion of this railway has been reconstructed so as to be suitable for speeds up to 60 or 70 miles per hour. The trials are being made with two large locomotives purchased from the Great Westery Ry. Co.

The following account of the apparatus and its operation is taken from the engineering supplement of the London "Times":

The two miles of track which Mr. Angus has constructed are divided into three sections, and between each two sections there is a signal box. These signal boxes, which would, perhaps, be better termed control boxes, enable the stationmaster or other authority to direct the course of trains at junctions and to determine what train shall have priority of admission into a given section of a single line.

In each section there are six ramps, three toward one end and three toward the other, placed between the running rails. They are 30 ft. or 40 ft. long and are similar in construction to those

which are employed for signalling purposes on certain portions of the Great Western Ry. Standing up a few inches above the level of the rails, they are struck by a shoe which depends from the locomotive and which is so shaped as to reduce the shock of the impact to a minimum.

The ramps are connected electrically to an overhead telegraph wire which runs alongside the line. As a matter of fact, two wires are used on the Watchet installation; but one is stated to be sufficient. The return is by the earth. The source of the power which works the apparatus is carried on the engine; it may be a generator of any kind, but at Watchet it consists of a battery, and the current employed is measured in milliamperes, with a very low voltage. The ramps, the telegraph wire, and the apparatus on the engine and in the control boxes constitute the whole of the equipment, and there are no outdoor or fixed signals. It is claimed, therefore, that apart from questions of safety, the cost of equipping and maintaining such a system would be very small.

The indications given are in every case positive; that is to say, the engine-driver is informed if the section he is about to enter is free, and he is equally informed if it contains another train. Supposing the section in front of him to be clear, then when the engine comes over the first of the three ramps at the end of the preceding section a deep-toned whistle is sounded, and it is again sounded at each of the other two ramps in the section, and also at each of the three ramps at the beginning of the succeeding section. The whistle is chosen because the action of the apparatus has to be demonstrated to a large number of people, all of whom cannot be on the engine, but a miniature semaphore, or a colored light, or a bell, or a buzzer can be put on the engine in substitution, as preferred.

But supposing that the following section contains a train and, therefore, cannot be entered without danger, then the indications are equally positive, and, moreover, are translated into action if the driver does not heed them. At the first of the three ramps toward the end of the preceding section a shrill whistle is sounded, or some other equivalent sign is given. The driver is free to ignore it if he likes; indeed, he is able to switch out the whistle or other device so that no visual or audible intimation is given him. But if he does so, then at the second ramp he finds that the control of the train is taken out of his hands, because the throttle is closed automatically and the continuous brake is applied. From this predicament the way of escape is not easy, for he has to go through various formalities before he can obtain the key that will enable him to leave the section, and he stands convicted of the most heinous sin he can commit—that of ignoring signals.

If two trains are running in opposite directions on two adjacent sections of a single track line, warning is given to both of them, and if no attention is paid to it the steam is cut off and the brakes applied on both. The position of the ramps is, of course, so chosen with reference to the gradients, the average speed, the braking power, and other circumstances that the trains are brought to a standstill before they enter forbidden ground.

As regards defects in the apparatus, should there be a short circuit the two whistles, shrill and deep, sound simultaneously, and disregard of the warning leads to automatic stoppage of the train. Similarly, if the telegraph wire be severed, or the engine start off without a battery or with an exhausted battery, the result is the same.

Panama Canal Excavation during June, totaled 2,339,700 cu.yd., a daily average of 93,590 cu.yd. for each of the 25 working days. The rainfall for the month was 10.84 in. The amount of concrete laid during June was 87,276 cu.yd. and 406,872 cu.yd. of fill were placed in dams.

Septic Tank Litigation is in progress at Chicago in the case of the Cameron Septic Tank Co. vs. the United States. The taking of testimony in this case was resumed at Chicago on July 5. The plaintiff in the case claims that the septic tanks built by the Government at a number of sewage disposal works at various soldiers homes and army posts are an infringement of the Cameron patent. The case is being tried before the Court of Claims by a special act of Congress. The decision of the court can be appealed by either side to the U. S. Supreme Court. The counsel for the plaintiff in the case is Mr. Henry L. Clarke, assisted by Mr. H. G. Wylie, of the Cameron Co. The defense is being conducted by Mr. Walter Pumphrey and Mr. John Q. Thompson, Assistant Attorney-General. The engineering side of the government's case is in the hands of Mr. Clyde Potts.

Street and Allied Improvements carried out at Victoria, B. C., in 1911, included 330,000 sq.yd. of pavement, 22 miles of sidewalks, 18 miles of sanitary and 36 miles of storm sewers, and 35 miles of water mains. A total of 725,000 sq.yd. of pavement was contracted for in 1911, of which 330,000 were completed in that year, as just stated, and 175,000 had been laid up to June, 1912.

Nearly all the improvement mentioned is sheet asphalt, laid by the Canadian Mineral Rubber Co., and a local company. Sidewalks and sewers are built by day labor. Common labor is paid $3 a day of 8 hr. The employment of Hindu, Japanese or Chinese laborers is prohibited. C. H. Rust, for many years city engineer of Toronto, has been city engineer of Victoria since May, 1912, and A. E. Foreman is principal assistant engineer in charge of all outdoor work.

Casualties in Ocean Passenger Traffic were the subject of statistics given by the Attorney-General to the British Board of Trade in connection with the British Government inquiry into the loss of the "Titanic." During the ten years from 1892 to 1901 the total number of passengers carried in both British and foreign ships between Great Britain and North America was 3,250,000, of which by far the greater proportion were carried in British ships. During that ten years the number of passengers lost by casualties at sea on these voyages to vessels belonging to Great Britain was 66 westbound and seven eastbound. During the ten years ending in 1911, 6,000,000 passengers were carried, the total losses being westbound, 8; eastbound, 1.

Personals

Mr. Edmund Stormoski has been appointed Superintendent of Sewers of Milwaukee, Wis.

Mr. F. W. Blodgett has been appointed Superintendent of Street Construction of Milwaukee, Wis.

Mr. S. I. Foster, formerly Assistant City Engineer of Troy, N. Y., is now City Engineer of Amsterdam, N. Y.

Mr. B. L. Durst has been appointed City Engineer of Port Arthur, Tex., succeeding Mr. C. E. Dunwoodie, resigned.

Mr. Hugh C. Liebee has resigned as City Engineer of Yankton, N. D., to become Assistant City Engineer of Sioux Falls, S. D.

Mr. Carl Gray, Jr., has been appointed Assistant Engineer of the Oregon Electric Ry. and of the United Rys. Co., at Portland, Ore.

Mr. A. N. Williams has been appointed Superintendent of the Missouri, Kansas & Texas Ry. at Trinity, Tex., succeeding Mr. W. P. Danforth, promoted.

Mr. Irving W. Barbour, formerly Assistant Commissioner of Highways of Oregon, has been appointed Highway Engineer with the United States Office of Public Roads, Washington, D. C.

Mr. George F. Quest, until recently Superintendent of Construction at Lockport, N. Y., on the New York State Barge Canal, is now connected with the Phoenix Construction Co., Lincoln, Ala.

Mr. F. P. Clark has been appointed Assistant Superintendent of the suburban service between Chicago and Aurora, Ill., of the Chicago, Burlington & Quincy R.R., with headquarters at Chicago.

Mr. James A. Bendure, formerly with the Economy Light, Fuel & Power Co., of Lockport, N. Y., is now with the contracting department of the American District Steam Co., North Tonawanda, N. Y.

Mr. William L. Vennard, for 22 years in the engineering department of the city of Lynn, Mass., has been appointed City Engineer, succeeding the late G. I. Leland, whose death was noted in our issue of May 23.

Mr. Arthur E. Duram, recently of the engineering staff of the Central Station Engineering Co., Chicago, Ill., has accepted a similar position with the American District Steam Co., of North Tonawanda, N. Y.

Mr. Charles A. Gilham, until recently with the Central Station Engineering Co., of Chicago, Ill., is now with the contracting department at Chicago of the American District Steam Co., of North Tonawanda, N. Y.

Mr. W. L. Rohbock, formerly Assistant to the Chief Engineer, has been appointed Chief Engineer of the Wheeling & Lake Erie R.R., succeeding Mr. H. T. Douglas, Jr., who has become Chief Engineer of the Chicago & Alton R.R. as noted in our issue of last week.

Mr. J. R. Sexton, recently Division Master Mechanic of the Atchison, Topeka & Santa Fé Ry., at Shopton, Iowa, has been promoted to be Mechanical Superintendent of the Western lines, Northern district, at La Junta, Colo., succeeding Mr. M. J. Drury, promoted, as noted in our issue of May 23.

Mr. Byron T. Gifford, Jun. Am. Soc. M. E., formerly with the Central Station Engineering Co., Chicago, Ill., has been appointed Manager of the general engineering department of the American District Steam Co., of North Tonawahda, N. Y., with offices in the First National Bank Bldg., Chicago.

Mr. J. R. Decker, Assistant Signal Engineer of the Michigan Central R.R., at Detroit, Mich., has been promoted to be Division Engineer at Bay City, Mich., succeeding Mr. E. R. Lewis, who resigned to become Chief Engineer of the Duluth, South Shore & Atlantic R.R., as noted in our issue of July 4.

Mr. Maurice C. Tomkins, for several years Sales Engineer of the Portland Iron & Steel Co., Portland, Maine, has been appointed New England representative of the Ohio Ceramic Engineering Co., of Cleveland, Ohio. Mr. Tomkins' headquarters will be at 201 Devonshire St., Boston, Mass.

Mr. M. B. Yung, a Chinese engineer, at present located in San Francisco, Calif., has been selected by the authorities of the Chinese Republic to superintend the reconstruction of the city of Hankow, China, which was burned during the recent revolution. Mr. Yung was educated at Yale and Columbia Universities.

Mr. H. K. Faust, for the past four years with the street department of Baltimore,

Md., has been appointed Chief Engineer of the Street Department, succeeding Mr. W. C. Sucro, who was recently appointed Road Engineer of Baltimore County. The salary of Chief Engineer of the Street Department is $2500 per annum.

Mr. John T. Dickerson, Assoc. M. Am. Soc. C. E., formerly Assistant Engineer, Sales Department, Scherzer Rolling Lift Bridge Co., Chicago, Ill., has been appointed Sales Engineer of the Strauss Bascule Bridge Co., in charge of its Eastern district, with headquarters in New York City, succeeding Mr. G. C. Bartram, resigned.

Mr. J. E. Taussig, formerly Superintendent of Terminals at Houston, Tex., of the Galveston, Harrisburg & San Antonio Ry., has been appointed Superintendent of the Houston division, with headquarters at San Antonio, Tex., succeeding H. F. Anderson. Mr. Taussig is succeeded at Houston by Mr. H. J. Micksch formerly Assistant Superintendent at Houston.

Col. W. C. Gorgas, Assistant Surgeon General of the United States Army and Chief Sanitary Officer of the Panama Canal Zone, has declined an offer to become Chairman of the Board of Health of Boston, Mass. In declining Mayor Fitzgerald's offer Col. Gorgas wrote: "I think that both my duty and interests require me to remain here until the actual completion of the canal. It is my life work and I wish to see it completed."

Obituary

George M. Hill, State Harbor Commissioner of California, died, at St. Mary's Hospital, San Francisco, on July 10, following an illness of several weeks. Mr. Hill was born in San Francisco in 1867 and graduated from the University of California in 1889, a classmate of Governor Johnson of California. After leaving college he became a mining engineer, and for a number of years was superintendent of mines in British Columbia and in his native state. Later he returned to San Francisco and engaged in the real estate business. He was appointed a member of the State Harbor Commission in January, 1911, and because of his engineering training and experience he had been selected by his colleagues on the commission to take charge of its engineering department.

Andrew E. Stevens, Manager of the Consumers Power Co., of Minot, N. D., was killed, June 22, in an automobile accident near his home. He was born in Rushford, Minn., Feb. 7, 1869, and educated in the public schools of Winona, Minn., and at the University of Minnesota. For a number of years he was engaged in street railway work in Minneapolis and St. Paul, and for several years was Manager of different telephone exchanges for the Wisconsin Telephone Co. He also served several years in the sales department of the Fort Wayne Electric Works. Since 1911 he had been associated with H. M. Byllesby & Co., Engineers, of Chicago, Ill., operators of the Consumers Power Co.

Henry Fink, Chairman of the Board of Directors, and formerly President of the Norfolk & Western Ry., died, at his home in New York City, on July 15, after a long illness. He was born in Germany in 1831 and received his engineering education at the Polytechnic School at Darmstadt. He came to this country as a young man and entered upon railway work in 1851 as a rodman on the Western Maryland R.R., soon becoming a transitman. Later, in the same year, he was a topographer and draftsman on the surveys for the Parkersburg branch of the Baltimore & Ohio R.R. When the road came to be built he was appointed Resident Engineer on construction and held this position for three years, until the completion of the work in 1855. For the three following years he was Resident Engineer on the construction of the Norfolk & Petersburg R.R. in Virginia. For the 13 years, 1858 to 1871, he was Master of Road, Master of Transportation and Superintendent of Transportation of the Norfolk & Petersburg R.R., the South Side R.R. and the Virginia & Tennessee R.R. From 1871 to 1876 he held a similar office with the Atlantic, Mississippi & Ohio R.R., and for the five years following he was Receiver for the same railway. Thereafter he held executive positions with various southern railways and was Receiver of the old Norfolk & Western R.R. Upon the reorganization of the company in 1896 Mr. Fink was made President, and held this office until a few years ago.

Stewart S. Neff, Vice-President of the Philadelphia & Suburban Elevated R.R. Co., which proposed to build a subway with elevated connections under Broad St., Philadelphia, Penn., died, on July 9, at the age of 54 years. He was born in Cincinnati, Ohio, and attended the Rensselaer Polytechnic Institute. Following his school work he entered the engineering department of the Pennsylvania R.R. as a transitman, becoming Assistant Engineer in 1883. From 1884 to 1887 he was Assistant Supervisor on the Pennsylvania R.R. He resigned this position in 1887 to become Superintendent of the Cornwall R.R. In 1891 he went to the Northwest to become Superintendent of the Coast lines of the Great Northern Ry., and for a year was General Manager of the Pacific Navigation Co. After a year as Assistant Engineer of the Vandalia R.R. he became Superintendent and Chief Engineer of the Lake Superior & Ishpeming Ry., 1895-96. In 1897 he was appointed Superintendent of the Union Elevated R.R. in Chicago, Ill., and since then he had devoted his whole attention to street railway and elevated railway work. From 1900 to 1901 he was Consulting Engineer and Superintendent of the Boston Elevated Ry. For a year he was Superintendent of the Mexican Tramways Co., at Mexico City, and then returned to the United States, in 1905, to superintend the construction of the shore line electric railway from Atlantic City to Ocean City, N. J. Later he became President of the Inter-State Engineering & Supply Co., of Philadelphia.

Engineering Societies

COMING MEETINGS

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS.
Aug. 26-30. Annual convention at Peoria, Ill. Secy., Clarence R. George, Houston, Tex.

TRAVELING ENGINEERS' ASSOCIATION.
Aug. 27-30. Annual convention at Chicago, Ill. Secy., W. O. Thompson, N. Y. C. car shops, East Buffalo, N. Y.

INTERNATIONAL CONGRESS FOR TESTING MATERIALS.
Sept. 2-7. Sixth congress at New York City. Secy. of organizing committee, H. F. J. Porter, 29 West 39th St., New York.

MICHIGAN GAS ASSOCIATION.
Sept. 4-6. Annual convention at Toronto, Ont., and on board steamer "Rochester." Secy., Glenn R. Chamberlain, Grand Rapids Gas Light Co., Grand Rapids, Mich.

INTERNATIONAL CONGRESS OF APPLIED CHEMISTRY.
Sept. 4 at Washington.
Sept. 6-13 at New York City. Secy., Bernhard C. Hesse, 25 Broad St., New York.

NEW ENGLAND WATER WORKS ASSOCIATION.
Sept. 18-20. Annual convention at Washington, D. C. Secy., Willard Kent, Narragansett Pier, R. I.

AMERICAN PUBLIC HEALTH ASSOCIATION.
Sept. 18-20. Annual meeting at Washington, D. C. Secy., Selskar M. Gunn, 755 Boylston St., Boston, Mass.

American Society of Mechanical Engineers—This society has received an invitation from the Verein Deutscher Ingenieure to hold a joint meeting with that Society at Leipzig, Germany, June 23-25, 1913. The Council of the American Society has accepted the invitation on behalf of the Society and has appointed a Committee to make arrangements for the meeting with Col. E. D. Meier as Chairman and President Alex. C. Humphreys and Secretary Calvin W. Rice as members ex-officio.

National Association of Cement Users—The annual convention will be held in Pittsburgh, Penn., Dec. 12-18, in connection with the Pittsburgh Cement Show of the Cement Products Exhibition Co. A second cement show will be held at Chicago, Jan. 16-23. The reason given for the selection of Pittsburgh for the eastern show in place of New York City is the desire of the management to hold a show in new territory. The Pittsburgh show will be held at Exposition Hall, which has even more floor space than the Coliseum in Chicago.

American Chemical Society—A general meeting will be held on Wednesday, Sept. 11, in the Doremus Theater of the College of the City of New York for the transaction of necessary business. Out of courtesy to the Eighth International Congress of Applied Chemistry no meeting for the reading of papers will be held at this time.

International Association of Fire Engineers—The program of papers for the convention at Denver, Colo., Sept. 17-20, is as follows: "Fire Prevention and Building Inspection by Members of Fire Departments," Fred Brodbeck, Salina, Kan., and A. M. Schoen, Atlanta, Ga.; "The Triple Combination Hose Wagon, Chemical and Pumping Engine," F. J. Connery, New Castle, Penn.; "The Proper Location of Sprinkler Tanks; on Roofs or Separate Towers," J. A. Tremblay, Montreal, Canada; "Tractors for Steam Fire Engines, Aerial Trucks and Water Towers," John Kenlon, New York, and R. H. Bawker, Passaic, N. J.; "The Care of Fire Hydrants to Prevent Freezing and the Best Way to Thaw Out Frozen Fire Hydrants," C. W. Ringer, Minneapolis, Minn., and John Aiken, London, Ont.; "Direct Connection From City Water Mains to Sprinkler Systems and Standpipes," F. A. Raymond, New York; "Motor vs. Horse Drawn Apparatus in Heavy Snows," James Smart, Calgary, Canada; "The Efficiency of the Motor Pumping Engine," George W. Boothe, New York; "A Review of the Association's Work for the Past Ten Years," Howard L. Staunton, Norwich, Conn.

Engineering Literature

CONTENTS

EDITORIAL.....129
CORRESPONDENCE
Further Remarks on a "Question of Credit;" R. F.—Supplementing a Review; A. Streiff—The Review of "German Varnish Making"; A. H. Sabin—A Reply to Hayford's Review of Ingram's "Geodetic Surveying;" E. L. Ingram; John F. Hayford.....130
REVIEWS:
Sewage Disposal. Reviewed by Harrison P. Eddy.....131
Waterways Versus Railways.....133
Power House Design. Reviewed by Harry L. Parr.....135
A Laboratory Manual of Physics and Applied Electricity. Reviewed by Chas. F. Scott..136
Water Analysis for Sanitary and Techincal Purposes. Reviewed by H. W. Clark....136
Centrifugal Pumping Machinery. Reviewed by Clinton B. Stewart.....127
The Art of Illumination.....137
The Official Good Roads Year Book of the United States.....138
Concrete and Stucco Houses.....138
Forney's Catechism of the Locomotive.....138
Addresses to Engineering Students.....139
Building Stones and Clays.....139
The Champlain Tercentenary.....139
The Engineering Index Annual for 1911.....139
PUBLICATIONS RECEIVED.....139

EDITORIAL

The authors of the book on "The Subways and Tunnels of New York," which was reviewed in our issue of June 13, say that the reviewer misunderstood the nature and purpose of the book, which was not intended and does not claim to be a complete treatise on the subway and tunnel work which it describes. It is simply a brief record of some of the more important facts regarding these works, gathered from a number of duly accredited and widely distributed sources, and combined in one volume for the convenience of engineers, contractors and others who seek such practical information on contract methods and costs as the book contains. The authors recognize as fully as does the reviewer the manifest impossibility of presenting exhaustive descriptions of works of such magnitude in one such volume as the book reviewed.

The authors say: "The book is not an essay on subways and tunnels, nor does it attempt to give opinions; but it does record the facts. It is a record of experience. That experience is, of course, a very broad one and it is impossible that it should be made complete in this one volume. It is true that much of the matter is abstracted from papers read before the American Society of Civil Engineers. This is duly credited in the preface (page 10) and throughout the book. If this is not done strictly in accordance with the rules of the Society, it is to be regretted. But as the plates in the great majority of cases throughout the book were furnished by the Society with the full knowledge that they were to be used in the book, this point should hardly be given serious consideration.

"The chapters are not divided in a haphazard way, but are arranged in chronological order according to the inception and, so far as might be, the progress of the various projects. Wherever possible the sources of information are acknowledged, and where this acknowledgment is not specifically made in the body of the book the explanation is clearly stated in the preface.

"It is true that the descriptive part of the book contains a great deal of matter relating to air compressors and compressor plants. For this the authors make no apology, as anyone qualified to express an opinion on the subways and tunnels of New York knows that compressed air was the key to the whole system of construction and that, with scarcely any exception, it was the power used throughout. This is especially true in connection with the tunnels under the North and East Rivers, where compressed air was the one and only solution of the problem. Admitting this, is it not important that full particulars should be given of the air compressors and compressed-air appliances used?

"The appendix is large—about as large in volume as the subject matter of the book itself. But it is clearly classed as an appendix and anyone taking the pains to look over the things that are in this appendix will see that it contains valuable information for the engineer doing tunnel work—information such as has not before been gathered together under one head. In fact, the reviewer himself admits that the information gathered in this section of the book may be useful for reference. It is not true that the first of the authors (Mr. Gilbert) is an employee of a rock-drill company. He is an engineer and contractor of high standing, experience and ability, and at the present time the executive head and chief engineer of a large firm of engineering contractors. He has at times in the past been retained by a rock-drill company as a consulting engineer on certain specialties of his own.

"That part of the book relating to the Pennsylvania tunnels is the largest and most complete because sources of information on this part of the work were numerous and available. In fact, a detailed description of the work on the Pennsylvania Tunnels was largely representative and in a sense descriptive of the methods employed in all the tunnels. Less information and less space were given to the Hudson & Manhattan Tunnels because reliable information about this section of the work was hard to get, and at the time this material was collected, Mr. Jacobs' paper before the Institution of Civil Engineers had not been published, or at least was not yet available on this side of the water.

"It is not true that the text of this book was thrown together in haste. On the contrary, many months of hard work were put upon it, seeking the facts and figures. In fact, the preparation of this matter extended over a year and a half.

"As stated above, the book in question does not pretend to be a complete description of the subways and tunnels of New York. No criticism is made in the review as to the accuracy of the facts and figures presented. In collecting data of this kind from a number of such sources it is quite possible that errors may have crept in. But anyone who can point out such errors will confer a favor upon the authors."

A notable consolidation of journals devoted to the cement and concrete interests has recently been announced, taking effect on July 1. The *Cement Age*, of New York, and *Concrete*, of Detroit, have been consolidated under the name of the *Concrete-Cement Age*. Six months ago the *Cement Age* absorbed the journal *Concrete Engineering*, so that the new publication really represents a consolidation of three former independent periodicals. The new journal will be published in Detroit with branch offices in New York City and Chicago. Robert W. Lesley will be connected with the consolidated journal with the title of Consulting Editor, which means perhaps a less militant position than the famous post of Contributing Editor. Allen Brett is to be Managing Editor and Walter C. Boynton, General Manager. The consolidation of three competing journals, occupying a comparatively limited field, should result in the establishment of a journal which should be able to command a much wider clientele and better support from the industry it represents.

CORRESPONDENCE

Further Remarks on a "Question of Credit"

Sir—An interesting parallel to the "Question of Credit" raised by Mr. Hunt in your issue of May 16 (page 947) may be found in the files of ENGINEERING NEWS for 1887.

The ex-chief engineer of a prominent railroad, whom we will call Mr. B, wrote a letter entitled "An Unsafe Floor Beam." (See ENG. NEWS, June 25, 1887.) This called forth a lively rejoinder from some bridge builders. Mr. B had taken the precaution to fortify himself with an opinion from a widely known bridge engineer, whom we will call Mr. C. For this opinion he paid a fee. In answering his critics Mr. B published the opinion of Mr. C. This called forth a letter from Mr. C in which he stated that when he wrote his opinion he considered it for Mr. B's *"own private guidance."* To this Mr. B replied that a confidential communication would have been utterly worthless.

Supplementing the questions mentioned in your editorial comment as involved, there is a third: For what service does the giver of clerical assistance in cases such as mentioned receive a fee?—that is, from the clerk's standpoint. It would have been interesting if Mr. Hunt in his communication had stated his views on the subject.

R. F.

New York City, May 21, 1912.

Supplementing a Review

Sir—Permit me to add a few remarks to Prof. Jacoby's review* of Prof. Hudson's book, "Deflections and Statically Indeterminate Stresses," which may be of interest to users of the work.

The book does not contain some important constructions, as the calculation of deflection polygons of straight and curved beams and trusses. It gives only Williot's diagram and the computation by means of the principle of virtual velocities, and does not mention the third, which is in fact the most important method for moving loads..

Some of the solutions offered by Prof. Hudson are not very short and practical. Take, for example, the Blackwell's Island Bridge. Why not calculate this structure exactly as a truss on four supports? The two center piers are much handier to operate with than the rocker arms.

Neither does the solution of the hingeless arch appear to be an improvement. Prof. Hudson places the unknown quantities V, H and M (vertical force, horizontal thrust, and moment) at the crown section. More than 20 years ago it was shown (by Prof. Mohr, I think) that by placing V, H and M at the center of gravity of the elastic weight the three elasticity equations resulting contain only one unknown each. Then, by dividing the arch so that $\frac{ds}{I}$ = constant, as done, for instance, in "Turneaure and Maurer," a part of the figuring done by Prof. Hudson is eliminated.

Contrary to Prof. Jacoby's opinion, I do not think that this book "fills the bill" for the student who wishes a work giving him a complete outline of this special field of applied mechanics, if it is intended to be such.

A. STREIFF.

Jackson, Mich., May 25, 1912.

*Eng. News, Jan. 18, 1912, p. 128.

The Review of "German Varnish Making"

Sir—In a friendly and appreciative review of my translation of Prof. Bottler's recent book, Mr. Job, a well known and disinterested expert, says that the author "does not appear to mention the well demonstrated fact that the so called mixed pigments, namely, mixtures of white lead, zinc oxide, with or without admixture of various inert pigments, prove much more durable in service than either white lead or zinc oxide alone."

The reason is that the author does not regard this as a demonstrated fact; it may be a fact, and no doubt the reviewer and many others regard it as demonstrated by their own experience; but the writer knows of no carefully conducted and disinterested tests which show it. A railroad company, for example, may be required to repaint station buildings every four years, to keep them looking fresh; they will conduct tests to find the cheapest four-year paint; but such are not true durability tests, for most buildings stand six to ten or more years between paintings.

So far, all the published tests known to the writer have been made by parties who were interested in having the results come out that way. It is not meant that such tests were never honestly made; the writer has no particular tests in mind; but in fact, the great majority of painters by occupation, who may be short of scientific knowledge, but have at any rate a large amount of practical experience, do not believe any such thing; and until a properly conducted investigation shows if, when, and why, such mixtures are advantageous to the consumer, it seems better to avoid a dogmatic statement which is contrary to general belief.

The author of the book in question has elsewhere expressed a personal opinion that in certain cases some, not all, paint mixtures have advantages; and is connected with a company which is a large maker of such mixed paints; but a personal opinion, though a proper guide in purchasing materials, and invaluable to an advertising man, is not to be set forth in a technical treatise, as a law.

It seems, in fact, irrational to suppose there can be such a law. It may be desirable, for example, to add white zinc to white lead for certain purposes, but it does not follow that if zinc is not at hand, equal results will be had by adding whiting, or gypsum, or barytes to lead. Lithopone, but not white zinc, with shellac makes an enamel paint; but it does not follow that lithopone is better than zinc in oil; the nature of the vehicle and all other factors affecting durability must be considered. Zinc added to any good outside paint will probably give less favorable results in a city, where much sulphurous acid is present in the air, or on the coast, than in the country. There is no law about it; each case must be judged on its own merits.

A. H. SABIN.

129 York St., Brooklyn, N. Y.,
June 13, 1912.

A Reply to Hayford's Review of Ingram's "Geodetic Surveying"

Sir—I have read with interest the review of my book on "Geodetic Surveying" in ENGINEERING NEWS of Apr. 18, 1912. In view of the apparent spirit in which the review is written I feel that I may venture to offer certain comments.

In over three columns of print devoted to this review there can be found but a single commendatory sentence, and specifically not a good word for even a single article. The adverse criticisms range from those of debatable merit, in view of the expressed scope and purpose of the book, down to those that are incorrect. It is clearly stated in the preface that the book is not written for the professional geodesist, but for the civil engineer and the civil engineering student. I am fully aware of the practice of the Coast Survey Department, but the civil engineer is likely to work under very different conditions. The reviewer's experience in the highest class of geodetic work makes him an authority in this particular class of work, but it does not follow that everything else is bad practice, or that civil engineers should use no other methods for their special needs. In view of the above facts I feel justified in protesting against a review whose character is wholly one-sided. A detailed reply to every point raised in the review can scarcely be considered desirable, but a few illustrations may be given to show my position.

The question of the strength of figures, for instance, is often a very complicated one, calling for careful consideration by the most experienced men. The slender treatment found in some recent

textbooks is of doubtful value. In the occasional cases when a civil engineer has to make surveys of an unusual extent he may wisely adhere to what are evidently well shaped figures. Again, it is a well known fact that the precise level work of the trained observers of the Coast Survey Department is of a high grade, although performed in large part under adverse circumstances. This by no means proves that the work is independent of such conditions, nor that a higher grade of work is impossible. Notwithstanding the practice of the Coast Survey Department, the civil engineer may well avoid attempting work of the highest class in strong winds and boiling atmospheres.

It is not considered necessary that an engineer should demonstrate every formula that he may have occasion to use. The Coast Survey Publications, even those written by the reviewer, contain many formulas without demonstration or reference to where such demonstration may be found. In each chapter or class of work my book refers to the authority for the formulas given, but it was not thought necessary to repeat the statement under each individual formula. Where a demonstration is beyond the scope of the book the fact is so stated, and a list of works of larger scope is given at the end of the book.

It is more than doubtful that any statement can be made regarding the accuracy attainable in different classes of work that will meet with universal approval. Many writers avoid such issues entirely, or speak with great indefiniteness. In making each of my statements the highest possible authority was sought. Thus my statement in regard to longitude determinations by lunar occulations, which excites the reviewer's wonder, is given by Prof. Charles L. Doolittle in his "Practical Astronomy as Applied to Geodesy and Navigation," a work of unsurpassed reputation. Prof. Doolittle attributes the statement to the late Benjamin Peirce, a man of the highest professional rank.

The alleged "freak method" of writing the equations of condition in quadrilateral adjustment was adopted by Prof. J. B. Johnson in his standard work on plane surveying. In Prof. L. S. Smith's revision of this book in 1910 we find it still adhered to. On page 330 of my book will be found an example of the use of this method. I would be pleased to see this quadrilateral worked out in the same detail with less actual arithmetical work.

The most elementary sense of justice demands that a book review that devotes itself entirely to destructive criticism should be the result of a most careful reading. In one of the two examples of alleged errors the reviewer misquotes what my book actually states. The book does not state that the application of corrections for spherical excess will reduce spherical angles to plane angles, but it does state that a *proper* reduction would reduce this result. I then proceed to state that the common reduction of one-third of the excess for each angle of a triangle is mathematically incorrect. In the second example, the assumption that the four corners of a quadrilateral may be considered as lying in a plane was only made in connection with the determination of rules for its adjustment, and it was not intended to convey the idea that the assumption could be made for any other purpose. In the reviewer's own works the repeated reference to the point where the two diagonals intersect, and the use of other equally significant phrases, is a tacit assumption of the same thing for the same purpose.

The reviewer does not state very clearly what his objections are to the part of the book dealing with the adjustment of observations, but from the illustration given it would appear that they are based on the fact that I have avoided any mathematical treatment of systematic errors as being beyond the scope and purpose of the book. It may be noted that Prof. Mansfield Merriman, an exceptionally able mathematician, followed the same plan in his "Precise Surveying and Geodesy." In objecting to the statement which I make in regard to the probable errors of base lines, the reviewer is well aware that the principle given is the one which is universally accepted for the class of errors to which it refers.

In conclusion I think it is beyond dispute that a book review should be wholly judicial in character, and that I am warranted in protesting against the sarcastic note that pervades the entire review in question. I fully realize that my book is not free from errors, and am most anxious to have these errors rectified. I believe nevertheless that the book contains ample evidence of the painstaking care and labor bestowed upon it, and venture to hope that it will be found to serve a useful purpose among the readers for whom it was written.

E. L. INGRAM.

University of Pennsylvania, Philadelphia,
May 28, 1912.

[Prof. Hayford sent us the following reply to Prof. Ingram's criticism.—ED.]

Sir—In my review of "Geodetic Surveying," numerous page references are given. These make the review definite and concrete. If any person who may doubt the justice of the review, after reading the above letter from Prof. Ingram, will consult with the review before him the pages to which references are given, and study the book as a whole, I am confident that he will find the review to be justified.

JOHN F. HAYFORD.

Bocas del Toro, Panama,
June 20, 1912.

REVIEWS

Fuller's Sewage Disposal

Reviewed by HARRISON P. EDDY*

SEWAGE DISPOSAL—By George W. Fuller, Consulting Engineer and Sanitary Expert; M. Am. Socs. C. E. and M. E., etc. New York and London: McGraw-Hill Book Co. Cloth; 6¼ x 9½ in.; pp. xv + 767; 80 text figures. $6, net.

American literature dealing with one phase or another of the subject of sewage disposal is now becoming somewhat voluminous, although such problems have not been as frequent nor generally as acute in this country as in England. The number of books thus far written on this subject, by American scientists and engineers, is relatively small, and the appearance of a new work is an occasion for congratulation, especially when from the pen of one who has been so intimately connected with the study of this subject as has Mr. Fuller for the past 25 years.

As stated in the preface, the subject is divided into four main parts which might be given the following brief explanatory titles:

Part I, Composition and Decomposition of Sewage, and Sewage Bacteria,

Part II, Sewage Disposal by Dilution,

Part III, Removal of Suspended Matter from Sewage,

Part IV, Filtration, Oxidation and Disinfection of Sewage.

Much valuable data on the composition of sewage will be found conveniently tabulated in the first chapter, while, in the second, the subject of sewage decomposition is discussed in a manner which will prove interesting and helpful to the layman as well as to the specialist. Some fine distinctions in the use of terms are brought out in this book, which, if more commonly adopted in discussions and literature on the subject, would assist in avoiding some of the confusion which is now somewhat prevalent, especially in the minds of those who give to this subject only occasional study. One of these is the distinction between "anærobic decomposition" and "septicization," which terms the author points out should not be used interchangeably.

Opening Part II with a brief and popular discussion of the problem of sewage disposal and of the experimental methods which have been adopted in this country for the study of this subject, which studies are pointed out as having accomplished much to increase our knowledge of the art, the author proceeds to discuss at great length the disposal of sewage by dilution. This method is shown to be by far the one most commonly adopted in this country and to be now serving a population many times greater than that served by artificial methods of purification. Eight points are suggested as being worthy of careful consideration, with a

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view to assuring the successful operation of this method which is rightly shown to be as truly one of purification, though popularly often not so considered, as are any of the artificial methods involving the biological processes of oxidation. The views of extremists clamoring for the elimination of all sewage matter from streams are considered and their impracticability is pointed out. While it is acknowledged that in many cases present conditions are not satisfactory and improved means of diffusion and, in some cases, means for removing a portion at least of the organic matters from the sewage before their discharge, should be adopted, the treatment of water supplies to assure their safety, and the disposal of sewage by economic methods of adequate sanitary merit, is suggested as a wise policy, which may be followed to advantage in this country.

The subject of sewage disposal by dilution is discussed under three main headings: "Dilution in Inland Streams," "Dilution in Large Lakes," and "Dilution in Oceans and Tidal Estuaries."

In the chapter dealing with dilution in inland streams, the author discusses at length the more commonly accepted theories of the chemical and biological action which goes on in inland streams into which sewage is discharged. This discussion serves as a basis for the two following chapters upon dilution in inland lakes and tidal water, in which the differences in the chemical and biological action in these waters from those taking place in running streams, are clearly pointed out. The author has prepared a very complete résumé of American investigations of the disposal of sewage by dilution in inland streams, among which those of Hering in Chicago, Stearns and Goodnough in Massachusetts, and Hazen in Ohio are given prominence.

Attention is also given to the significance of flora and fauna in maintaining the purity of natural waters, and a number of pages are devoted to liberal abstracts of recent German literature translated by Kuichling.

In the discussion of dilution in large lakes the points of similarity and dissimilarity of conditions to those prevailing in rivers, is clearly set forth, followed by a very long abstract of the recent report on the inland lakes of the state of Wisconsin, by Birge and Juday; following which are brief paragraphs describing the various projects completed and proposed for the dilution of the sewage of several of the larger cities located on or near the Great Lakes.

In the consideration of the dilution in tidal waters, much attention is given to the studies which have been made upon this subject at Boston, Mass., and a number of projects, either constructed or contemplated, are briefly discussed.

In opening Part III, the author states that the disposal of sewage by treatment in works of artificial construction, becomes necessary, in some cases, through the failure of the dilution method to meet local requirements. This statement might well have been made much stronger, for this is the fact in the great majority of cases where purification in works of artificial construction have been required, although it is now the policy of some of the governmental boards to require the construction of purification works before newly built sewer systems are put into use.

This part of the book deals primarily with the removal of suspended matter from sewage, by processes which are, in most cases, used as methods of preparing the sewage for the second part of the purification process—that of oxidation, by dilution or by artificial works. These methods the author has very appropriately referred to as preparatory arrangements for the treatment of sewage.

After describing very briefly the various methods of treatment which are now available, including oxidation by filtration and sterilization, the subject of the screening of sewage is discussed. The chapter devoted to this subject deals briefly with a number of screens now installed and in use, and gives in full the specifications for the fine screening apparatus now being furnished by O. M. Weand for the Proctor Creek Disposal Works at Atlanta, Ga.

The subject of plain sedimentation is discussed at great length, the results of experiments and actual operation of some of the larger works in this country being set forth in some detail. In this chapter the author deals with grit chambers, skimming tanks, and apparatus for the removal of grease, as well as with the subject of sedimentation as ordinarily considered. There is also, in the closing pages, a brief discussion of the disposal of sludge. The theory of sedimentation is quite fully discussed, the article by Hazen, published in Vol. 53, *Transactions* of the American Society of Civil Engineers, serving as a basis. Attention is given to the suggestion of Dr. Imhoff—that it is more important to consider the effect of sedimentation processes upon the "settling solids" rather than the total suspended solids, as has been more commonly done in the past. The author refers to statements of Pierce to the effect that the use of the German conical glasses for measuring the volume of deposited solids, has not proved satisfactory with the dilute American sewages. Several tables of data, which will prove of assistance to engineers and others having to do with sedimentation problems, are given in this chapter. The author then takes up questions relating to types of tanks and features of their design, dealing with such topics as capacity; average, bottom and maximum velocities; baffles; relation of length, width and depth to each other; and the operation of basins in series and in parallel. Considerable attention is given to a consideration of the relative merits of horizontal and vertical flow tanks and of tanks with relatively flat bottoms and those having hopper bottoms for the more expeditious removal of sludge.

The amount of space devoted to a consideration of the sludge problem is very limited, and the data given are meager. While this subject receives incidental consideration in various other places in the book, it would seem that its importance and the difficulties of dealing with the sludge problem are so great that more space might well have been devoted to its consideration.

In the chapter devoted to septicization, attention is given to the history of the septic tank as well as to the efficiency of the process and the extent to which it has been used. There are several tables of the more important data relating to septic tanks, and the bacteriological and chemical processes involved are discussed. Brief consideration is given to the sludge problem, while the question of odor is discussed at some length. Considerable space is devoted to the discussion of separate tanks for sludge digestion, the two-story Hampton tank, and the Emscher tank. The septic and Emscher tank patents are also discussed with reference to the claims and rights of the patentees and the general attitude of the American engineers toward these patents.

The author has given a somewhat exhaustive discussion of electrolytic processes of sewage treatment, devoting rather more space to this subject than might be expected, in view of his conclusion that electrolytic treatment does not now seem to afford a practical means of sewage treatment. This may be justified, however, in view of the fascination it has for the layman, which fact is pointed out in the opening lines of this chapter and has been observed by most engineers who have had occasion to deal both with the public and sewage-disposal problems.

The fourth and last part of the book is devoted to the oxidation and sterilization of sewage. After a brief discussion of broad irrigation, intermittent sand filtration is discussed at length, the chapter containing a number of tables of valuable data. The various theories relating to this process are clearly discussed, and there are many hints which will prove valuable to engineers and chemists in charge of operating such filters.

A very full and valuable discussion of contact filters is given in one of the closing chapters of the book, in which the work accomplished by the Plainfield, N. J., filters is given a prominent place. The data relating to this plant are without question the most complete and valuable of any obtained in this country relating to this method of sewage treatment.

After discussing sprinkling filters, aëra-

tion as proposed by Black and Phelps, hypochlorite, and ozonization, there is a brief chapter on institutional and residential plants, after which the author closes with a brief comparative summary of the several methods of treatment discussed in the foregoing pages. This summary contains a few tables of interesting and valuable general statistics as to the relative efficiency, cost of construction, and cost of maintenance of the several processes. The closing paragraph deals with the need of good management of sewage-treatment works, relating to which the author makes several pertinent suggestions.

The book is written in a popular style, and will prove a valuable addition to the library of every engineer and chemist dealing with the problem of sewage disposal. It will also be found of particular value to health officers, lawyers, teachers, and students who have occasion to deal with the various phases of sewage disposal only occasionally and wish to secure information as to the natural and artificial processes involved. It is not copiously illustrated, but there are a few reproductions of drawings and photographs which will prove of interest and assistance to the designing engineer. The author freely draws from the literature on the subject, to make his explanations clear and furnish evidence on which to predicate the various theories, propositions, and conclusions. A valuable feature is the résumé, averaging perhaps one page in length, at the close of nearly every chapter. Here are briefly summarized the salient facts brought out in the preceding pages, and the reader is given a clear idea of the subject matter and the present status of the problem, method or device discussed. By reading the résumés one can get, quickly and with little labor, a very good general idea of sewage disposal.

An excellent piece of work, which should be useful to many engineers engaged in manufacturing industries, is found in the *Bulletin of the Bureau of Labor* for May. It is a list of industrial poisons which has been compiled by three eminent foreign chemists by request of a committee of the International Association for Labor Legislation. The list gives for each specific poison the name of the substance with its description, the branches of industry in which poisoning occurs, the mode of entrance of the poison into the body and the symptoms of poisoning. There are also given for each group of poisons the special measures of relief which should be adopted in cases of poisoning. It will be a surprise to many to see the long list of substances now in extensive use in the industries which present serious danger to the health of workmen and others. Copies may be had from the U. S. Bureau of Labor, Washington, D. C.

Waterways vs. Railways

WATERWAYS VERSUS RAILWAYS—(Hart, Schaffner & Marx Prize Essays XIII). By Harold G. Moulton, Instructor in Political Economy in the University of Chicago. Boston and New York: Houghton Mifflin Co. Cloth; 5¼x8¼ in. Pp. 468. $2, net.

There has long been great need for the publication of such a book as the one here reviewed. For years the public has been literally deluged with literature in favor of waterway development. Newspapers and magazines have teemed with articles setting forth the enormous gains to be made by the revival of water transportation. Books and pamphlets devoted to the same topic have been spread broadcast.

In fact, if the total outlay in these publications were added to that spent in connection with the numerous conventions held to promote the same object, the sum would doubtless amount to many millions.

And this expenditure for the "acceleration of public opinion" as an eminent politician has termed it, has brought results. The nation and the states are spending money on waterway development amounting to hundreds of millions, and these expenditures are to be doubled and quadrupled if the waterway enthusiasts have their way.

Now is this expenditure wise? Will it yield a return in the shape of public benefit, direct or indirect, proportionate to the enormous outlay which is being made? Are the statements and claims and arguments of the waterway promoters truthful? Are they based on sound premises?

These are questions, surely, in which the public that has to pay for these expenditures has a deep interest; but one will search the waterway uplift literature in vain for an answer to these questions which will satisfy a careful man, accustomed to weigh evidence and with some understanding of the technical questions involved.

It is a fact that ENGINEERING NEWS and one or two other conservative technical journals have stood practically alone in their protest against the reckless assertions and wild extravagance of the waterway promoters. In the stand we have taken on this subject, however, we have merely reflected the opinion of the majority of engineers, who have not been carried off their feet by the whirlwind of waterway agitation. Numbers of engineers have had the courage to speak out boldly and warn the public against the dangers of this huge campaign to increase public expenses.

Under these circumstances, the book before us is of especial interest to engineers. It is a careful, thorough, unprejudiced study, made by a professional economist, of the relative advantages of waterway and railway transportation. In June, 1911, this treatise was awarded the first prize of $1000 in the competition established by Messrs. Hart, Schaffner & Marx, of Chicago, for the best essay on economic and commercial subjects. The award of this prize was made by a committee of which Prof. Laughlin, of the University of Chicago, was chairman.

As showing the author's freedom from bias in undertaking this study, it is interesting to note that according to his own statement he began the task originally believing that traffic of certain kinds can be carried at substantially less cost by water than by rail. He also believed, however, that on some of the projects advocated by the waterway enthusiasts the traffic which could be secured was not sufficient to make them pay a fair interest on their cost.

The original purpose of the author, therefore, was merely to make an investigation of the traffic possibilities of certain projected water routes; but he soon found that no adequate analysis of the cost of water transportation had ever been made; that it was merely *assumed* by the waterway promoters that water transportation is cheaper than transportation by rail and that all their arguments were based on unproved assumptions.

As a large part of these arguments are based upon the alleged great success of water transportation in Europe, an investigation of European transportation conditions became imperative. The author went to Europe, supposing that water transportation on the Continent, at least, was of undoubted economic advantage. He was surprised to find that in Europe as in the United States little consideration had ever been given to determining the cost of transportation by water as compared with that by rail, and that the common comparisons of rail and water rates usually made in support of waterway development, were so manifestly incorrect in their assumptions that they proved nothing whatever.

It will be seen, therefore, that starting out with the accepted belief that the waterway was, under certain conditions, an advantageous means of inland transportation, the author became, as his investigation proceeded, "more and more at outright loggerheads with the advocates of waterway development."

The first chapter of the book entitled, "The Revival of the Agitation for Waterways," traces briefly the history of waterway agitation in the United States Cleveland International Waterways Convention of 1895. The chapter concludes with a list of the well defined waterway projects now being urged upon the attention of Congress; and it is interesting to note that the total estimated cost of these projects is in the neighborhood of $950,000,000.

In the next rather brief chapter the author discusses the causes of the revival of interest in waterway development. Next comes a rather long chapter

devoted to an analysis of current arguments for waterways. The author dissects these with keen intelligence and shows conclusively that most of the arguments advanced in favor of water transportation development in this country have not been based on a thorough study of the subject, and that many of the statistics presented in support of these arguments are grossly misleading. He proves conclusively that unless waterway transportation is actually cheaper than railway transportation, *when all the elements of cost are taken into account*, the claims made for the wide public benefits to be derived therefrom cannot be substantiated.

Chapter IV is entitled "A Nation-Wide System of Waterways," and is devoted to certain important general considerations which affect water transportation in any country. The author points out the influence of topography upon commercial development and shows that water-transportation routes are necessarily confined to natural valleys. Elevations can be surmounted by canals only at great expense and difficulty; and water supply for the summit level is always a controlling consideration. Under modern railroad conditions of construction and operation, however, the railway defies topography to a large extent. He shows further that where prompt delivery over long distances is essential, the waterway cannot possibly furnish the service that the railway gives. The waterway, further, is far more subject to the vicissitudes of weather than the railway. Alternate floods and low water are continually causing difficulties in water transportation. In a large part of the country, ice conditions in winter cause entire stoppage of waterway traffic. On account of its heavy fixed charges for cost of construction and maintenance a canal must have a very large traffic to be a paying enterprise. The list of commodities which it can carry in competition with railway lines is extremely limited.

In Chapter V a brief history of water transportation in the United States is given and the causes are set forth which have brought about the decline of water transportation here. The importance of this chapter may be indicated by quoting the following sentence:

> Before deciding to expend millions in the development of water routes, we should give careful attention not only to the unfair practices of the railways, but to the many other factors that have been operative in the defeat of our present waterways.

The author then turns his attention to the waterways of foreign countries. In Chapter VI the barge canals of Great Britain are described and also the agitation which has gone on in that country to revive water transportation, which resulted in the appointment in 1906 of a Royal Commission of Waterways. While this Commission presented in its majority report a scheme for rehabilitating English canals, nothing whatever has been done toward carrying out the Commission's recommendations and the author says in comment, "The grave political problems the nation is facing, together with the tremendous naval expenditures consequent upon the mad race with Germany for maritime supremacy, preclude the possibility of any immediate development of a comprehensive scheme of internal transportation facilities. Indications are that the discussion of waterways will gradually diminish until it altogether ceases to agitate the British public."

Chapter VII is devoted to the Manchester Ship Canal, which is one of the stock arguments of waterway advocates. "The building of this waterway," says the author, "was a magnificent engineering feat; but its economic advantages are very questionable." Up to Dec. 31, 1909, the cost of constructing and enlarging the canal amounted to $84,000,000. Although 16 years have passed since the canal was opened to traffic, the company has never yet been able to make ends meet. No dividend on the stock has ever been paid, and it has never been possible even to pay in full the interest on the $25,000,000 which was borrowed from the City of Manchester to complete the canal. Manchester business men are frank to admit that the canal has been a great disappointment. As for the argument that the indirect benefits of the canal have made its construction worth while, the author gives statistics which show that the increase in population in Manchester has been at a lower rate than that of other rival commercial cities in the North of England, and W. H. Acworth, the well known economist, states that the canal has had virtually no effect on railway rates. The author's conclusion is that since the circumstances in the case of the Manchester Ship Canal were all unusually favorable to construction and profitable operation, the failure of the canal to make either an indirect or direct financial profit is a strong argument that the extension of ocean transportation inland by such means is certain to be unprofitable.

Chapter VIII is a brief discussion of the proposed Forth & Clyde ship canal across Scotland. This is a much discussed project of which the minimum cost estimate is $100,000,000. The citizens of Glasgow have come to the conclusion that the commercial benefit of such a canal would not be sufficient to warrant their undertaking its construction unaided.

The two long chapters following are devoted to the waterways of Germany and the German transportation policy and are among the most important and interesting of the whole book. In Germany, if anywhere in the world, inland waterways are a success. In fact, this is generally taken for granted by most writers on transportation subjects. The author's investigations, however, indicate clearly that the actual total cost of waterway transportation in Germany is in excess of the cost of railroad transportation.

It is indeed remarkable that in a country governed with such scientific and technical ability as Germany, state support should be given to an uneconomical system of transportation. The author, however, suggests that nothing less than the personal influence of the German Emperor himself is responsible for the enormous expenditures on German waterways. Of course, as the author points out, there are many influential interests in Germany which find the maintenance and development of water transportation by the State greatly to their advantage.

In Chapter XI the author applies his study of German transportation conditions to the United States and presents strong arguments showing that even if German waterways could be regarded as successful, it does not follow that we could achieve equal success in the United States by following their example.

The following three chapters are devoted to the waterways of France, Belgium and Holland, respectively. The author then returns to projects for waterway developments in the United States. Chapter XV. is devoted to the Lakes-to-the-Gulf Ship Canal and discusses the probable cost and possible traffic of a waterway 24 ft. in depth from New Orleans to Chicago. He shows conclusively that a 24-ft. deep ship canal from Chicago to the Gulf would cost to build probably at least $1,000,000,000, and would have to carry an ocean traffic nearly double that of such great ocean ports as Philadelphia, Boston and New Orleans in order to effect saving enough merely to meet the annual outlays for interest and maintenance. Further than this, however, it is practically certain that no considerable number of ocean vessels could be induced to use such a waterway were it offered for use free of tolls.

The next chapter bears at its head the familiar slogan, "Fourteen Feet through the Valley." This project, as our readers will recall, was condemned three years ago by a board of army engineers appointed to report upon it. The latter portion of the chapter is devoted to a discussion of the value of the water power which was to be developed as a part of the Illinois end of the enterprise.

Chapter XVII is entitled, "A Depth of 8 ft. from the Lakes to the Gulf." A depth of this amount, in fact, already exists for a large part of the distance. The chapter is devoted to the discussion of what traffic such a waterway ought to command, and the extent to which it could compete with railway lines. The author shows that one of the reasons for the disuse of waterways is the fact

that most freight originates at points not reached by waterway lines. It is only under exceptional conditions of long haul that it will pay to introduce a transfer between a water and a rail line in the course of the journey.

Chapter XVIII is devoted to the improvement of the Ohio River, a work which has been formally approved by Congress and is now under way on a large scale. Its estimated cost is about $69,000,000, not including the harbor and terminal facilities, which will be necessary at the various cities along the river. The author analyzes the computations made by the Board of Army Engineers to determine the economic advantage of this work. The results obtained by the author may be summarized in the following quotation:

> The above analysis has shown that if tolls were to be charged upon the Ohio River sufficient in amount to defray the annual expenses of maintenance and operation, including interest on the invested capital, there is little doubt that the rates by river would be somewhat higher than those by rail on similar commodities. But unless water rates are substantially lower than those by rail, the traffic will seek the railroad. tI seems altogether certain, therefore, that the Ohio River, in the absence of government subsidies, would not be able to meet the competition of the railways.

Chapter XIX discusses the $101,000,000 barge canal which the State of New York is now building. The author reaches the same conclusion that was reached by ENGINEERING NEWS, when the project was agitated before its undertaking a dozen years or more ago, that if it was desirable for the state to enter the transportation business, a freight railway from Buffalo to tidewater could carry traffic at a lower cost than the barge canal.

In the concluding chapter of the book, the author gives an "Explanation of the Waterway Movement." He compares it to the agitation for internal improvements in the last century during the years 1825-1840. He shows that that agitation was based on such absurd premises and brought about such heavy expenditures on unwisely planned works that the State of Pennsylvania was carried into bankruptcy, and the State of Illinois had to default in the interest payment on its bonds in 1841, while repudiation of its entire debt was long imminent.

The author concludes his explanation as follows:

> Unless the whole question of waterways is removed from the domain of politics and placed in the hands of impartial investigating bodies, this country will doubtless continue to waste its millions in these projects for canal building and river improvement, the chief result of which will be to enlarge the patronage or further line the pockets of our practical politicians.

In the final summary of his conclusions, the author says that, so far as canals are concerned, "to attempt to return now to the antiquated system of transportation of half a century ago or to make canals an integral part of a national transportation system, whether for the carriage of high-class or low-grade freight, is to attempt to turn backward the clock of time."

We cannot too highly commend this book to the careful study of engineers the country over. The questions it discusses are questions on which it is extremely important that the engineering profession should have sound and authoritative information. It is a narrow viewpoint that says that because engineers are employed to build waterways, therefore, the more money spent on waterways the better. In the long run it will injure engineers as well as the public to have either public or private funds invested in enterprises which are wasteful and unprofitable. It is the engineer's business to make a dollar earn the most interest. That means that that system of transportation should be favored by engineers which can do the work most efficiently at the least total cost.

Power House Design

Reviewed by HARRY L. PARR*

POWER HOUSE DESIGN—By John F. C. Snell, Vice-President of the Institution of Electrical Engineers; M. Inst. C. E.; M. Am. Inst. E. E., etc. New York and London: Longmans, Green & Co. Cloth; 5½x9 in.; pp. 448; 17 folding plates, 186 text illustrations and 121 tables. $6, net (21/ net).

Twenty-five years ago the design of a power plant was a comparatively simple matter which could be easily carried out by any engineer familiar with steam engines, boilers and the few simple auxiliaries in use at that time, as there were practically no central stations, and the isolated plants were small. These conditions have now been completely changed, largely by the fact that the development of electrical distribution of power and light has permitted the use of large central stations and the field has been broadened by the introduction of large gas-power units and hydroelectric installations. The design of the steam plant itself has become very much more complex, as the production of power on a large scale has made necessary the careful study of many things affecting the initial cost, cost of operation, reliability of service, and their relation to each other, which were not deemed worthy of consideration in the old-time plant. Consequently, the present-day power-house designer must have a much greater fund of information than a working knowledge of the machines and apparatus which go to make up a plant. Until recently such information could be gained only by experience or by a study of a great number of technical books, professional papers and engineering periodicals. The author of this book, whose experience in this sort of work stretches over a period of some twenty years, has endeavored to give in one volume "all the requisite practical information on power-house design."

Three sources of power are dealt with, namely, steam, to which the major portion of the book is devoted, internal-combustion engines and water power. After a short chapter on the various systems of electrical transmission and their adaptability to different types of work, Mr. Snell opens the main subject with a discussion of the choice of site for a plant and the type of building to be erected. This discussion is illustrated by descriptions and plans of representative power plants in England, America and other parts of the world. Numerous tables are inserted, giving such information as average coal and water consumptions of large and small plants, average costs of buildings of different types and safe loads for foundations and building materials. Sample specifications for brickwork, concrete, structural steel, etc., are also included. The section devoted to the design of the boiler house is prefaced by a description of the best known types of boilers and the characteristics peculiar to each. This is followed by a detailed consideration of the factors influencing the choice of methods of coal handling, mechanical versus hand stoking, the use of economizers, forced versus natural draft and different types of feed-water systems. The capacities and dimensions of the different pieces of apparatus and their approximate costs are carefully tabulated. The steam and feed-pipe systems are taken up in a separate chapter, after which are two chapters on steam-power units and condensers, which are written with the same care and attention to detail as was shown for the boiler plant. The engineer using this book will be greatly assisted in his selection of the best types of machines to meet the particular requirements of the plant he proposes to design by the numerous tables and curves, showing the results of tests of engines and turbines of different sizes and how their economy is affected by variation of load, degree of superheat and vacuum. In this connection it should be remarked that Mr. Snell throughout the book emphasizes the necessity of providing in the design convenient means for testing every piece of apparatus, in order that the plant may be continually kept up to its maximum efficiency.

The two chapters devoted respectively to internal-combustion engines and hydro-electric plants do not attempt to give the detailed advice to the prospective designer which is given for the steam plant. In the case of the internal-combustion engine there is much valuable information concerning prices, dimensions, oper-

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ating expenses and characteristics of the most important types of engines and producers, but no definite method of design is laid down other than references to the descriptions and plans of a number of existing plants. In the chapter on hydro-electric plants, the author points out the principal factors entering into the design of a plant of this type, and describes in more or less detail several installations in different parts of the world, chosen apparently with the intention of illustrating the range of conditions which a designer of water-power stations may have to meet. He remarks very truly that a complete treatment of this subject "would require a treatise by itself," and an adequate discussion of rainfall, runoff and water storage scarcely falls within the province of this book. The remaining three chapters are devoted to a detailed description of switchgear, dynamos and motors and substations.

Mr. Snell appears to have succeeded admirably in producing a book to meet the need which he speaks of in his preface. As he is an Englishman he has naturally based his data on English practice, but he has been careful to note what is followed in America when there is any radical difference between the two, and many of the power plants referred to in the text are situated in New York or other parts of the United States. The principal discrepancies which the American engineer may be likely to find are in the estimates of cost of machinery. It is assumed throughout the book that the engineer who uses it is well informed concerning all types of power-plant apparatus. This may be assuming a little too much in some cases, and a bibliography of reference books from which such information could be obtained might prove acceptable. As this book is written for the use of practicing engineers it could not well be used as a general textbook for engineering students, but it no doubt would prove very useful as a reference book for advanced students in courses on power-plant design.

AMERICAN ROAD BUILDERS' ASSOCIATION. Proceedings of the Eighth Annual Convention, Held at Rochester, N. Y., Nov. 14-17, 1911. New York: The Association, 150 Nassau St. Paper; 6x9 in. Pp. 205.

A verbatim report of the proceedings of any engineering society (or of any other society, for that matter) is sure to contain a great deal of trivial matter. One who desires to extract useful information from such a volume must read over a great deal of desultory talk to find the records of important experience. The convention at Rochester brought together a number of engineers who have been most prominent in the work of improving road construction. Those interested in this branch of engineering work will find a number of interesting things in this report.

Physics and Applied Electricity

Reviewed by CHAS. F. SCOTT*

A LABORATORY MANUAL OF PHYSICS AND APPLIED ELECTRICITY—Arranged and edited by Edward L. Nichols, Professor of Physics in Cornell University. In two volumes. Vol. I.—Junior Course in General Physics. Revised and rewritten by Ernest Blaker, Assistant Professor of Physics in Cornell University. New York: The Macmillan Co. Cloth; 5¾x9 in.; pp. 417; 135 text figures; tables. $3, net.

The manual consists of two volumes, the first of which is the Junior Course in General Physics which has been revised and rewritten by Edward Blaker.

The first question with regard to laboratory manuals is as to the desirability of having a manual. Problems may be assigned and the student may rely entirely upon his own initiative without direction, or on the other hand a manual may be so complete that every move is explicitly directed. While each of these extremes may be advantageous under certain particular conditions, yet an intermediate course is generally advisable. The present book is of the intermediate kind. It gives the description of methods and of apparatus in a way to impart the information which should be available to the student—in fact, it is almost a textbook as well as a laboratory guide—it directs him in proper methods of observation and measurement, and enumerates various precautions to be taken, and yet does not do the student's thinking for him. At the end of many exercises there are suggested various items as "addenda to the report." These give opportunity for original thought and the drawing of one's own conclusions.

The book takes up in an orderly way a general treatment of physical and electrical topics, following a general introduction relating to records of observations, units, graphical representations of results and errors of observations and method of least squares. Measurements of length, mass and time are followed by experiments in statics, friction, accelerated motion, moment of inertia, simple harmonic motion, elasticity, density, gases, calorimetry, expansion, lenses and mirrors, photometry and sound. In the electrical division of the book static electricity, magnetism and electric current are followed by electromotive force, measurement of resistance, electrical quantity, electromagnetic induction and magnetic properties of iron. Under each of these groups are given explanatory general statements and a number of experiments. These deal with the fundamental facts and give the student a concrete acquaintance with the basic principles of the various subjects.

The manual seems to be a satisfactory combination of explanation, mathematical demonstration, general direction, and illuminating suggestion to the student. The book has not as many cross-references or references to other works in which the subject may be more fully explained as would be desirable.

In the view of the writer, the book outlines in a satisfactory way a course in Physics. No method, however, is complete without the teacher. An intelligent, inspiring and directing instructor is of more importance than the textbook, but the good book is a great aid to the good teacher. Presumably the present manual is the result of many years of experience in the teaching of Physics at Cornell.

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A Practical Water Analysis Handbook

Reviewed by H. W. CLARK*

WATER ANALYSIS FOR SANITARY AND TECHNICAL PURPOSES—By Herbert B. Stocks, Fellow of the Institute of Chemistry, Fellow of the Chemical Society, Member of the Society of Chemical Industry. London: Charles Griffin & Co., Ltd. Philadelphia, Penn.: J. B. Lippincott Co. Cloth: 5¼x7¾ in.; pp. viii + 136; eight text figures. $1.50, net.

This little book bearing date of January, 1912, might for all practical purposes have been written and published twenty-five years ago. It is a true type of the English textbook of that period upon water analysis, and apparently much, if not all, of the work done in this country and abroad in regard to improved methods, especially as elaborated in the report of the Committee on Standard Methods of Water Analysis of the American Public Health Association, issued about seven years ago, has been overlooked.

Some of the methods given in this book are obsolete and the newer methods are not well presented. Descriptions and illustrations of apparatus, especially for the determination of ammonia, are of apparatus as used many years ago and perhaps at the present time in some laboratories where only one or two samples of water are examined daily.

Many things of little practical value at the present time in water analysis are over-emphasized in this book, while important matters are overlooked or in some instances not carefully stated. As an example of the first assertion, eighteen pages of the book are devoted to a description of Frankland's combustion process. This process, while undoubtedly valuable in special investigation work, is of little or no value in ordinary sanitary work on account of the length of time consumed in carrying it out and the amount of apparatus required.

The time has gone by also when any of the results of chemical determinations can be reported as a "minute trace," "ap-

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preciable quantity" or "considerable quantity" as given in this work.

Students of sewage purification will be surprised to learn that "the destruction of practically all the organic matter in sewage is accomplished by a few hours' contact with a bed of porous material such as coke or clinkers."

In the preface the author states that "the microscopical examination is, however, included (in this book) as very often information is obtained from it which is exceedingly valuable. There are, however, only thirty-five lines on pages 7 and 8 devoted to this subject of microscopical examination and these lines contain absolutely nothing to assist a novice in making such an examination or anything of value for an expert on the subject.

Of course, many methods of analysis are correctly defined and there are many pages of interesting reading, but the book as a whole can hardly be recommended for the use of students, water analysts, etc.—at least in this country.

Centrifugal Pumps

CENTRIFUGAL PUMPING MACHINERY —The Theory and Practice of Centrifugal and Turbine Pumps. By Carl George de Laval, M. Am. Soc. M. E., Naval Architects and Marine Engineers, and Am. Soc. Naval Engineers. New York and London: McGraw-Hill Book Co. Cloth; 6x9½ in.; pp. viii + 184; 159 text figures; 19 tables. $3, net.

Reviewed by CLINTON B. STEWART*

The book describes in considerable detail the ordinary theory and design of centrifugal and turbine pumps, with application to installations that have been made by The Henry R. Worthington Co., together with a general description and results of tests of many of the largest and most important installations that have been made by the Worthington company. Several methods of design are taken up: first, by using the ordinarily accepted formulas expressing the head pumped against, as a function of the peripheral velocity, impeller vane angle at the circumference of the impeller, and hydraulic efficiency as shown by previous test; second, by expressing the relations between capacity, head and speed, Q, h and n, respectively, by an equation in the form

$$AQ^2 - BQn - Cn^2 = -2gh,$$

A, B and C being constants determined by previous tests. By assuming Q, h and n in turn as constants, characteristic curves are then obtained for constant capacity, constant head and constant speed.

For backward curved vanes the form used is limited to that of a single center curve. The effects of various impeller vane angles at the circumference of the impeller on the characteristic curves showing relations between capacity and power, capacity and head and capacity and efficiency for constant speed are stated briefly. The results of tests show that by careful designing the increase in power due to decrease in head can be kept within reasonable control for practically all conditions of service.

The theory of centrifugal pumps has probably been as far advanced as the present experimental knowledge of hydraulics will allow. Experimental data concerning the flow through curved channels, comparable to those between the vanes of impellers, and particularly of the changes in the form of transverse velocity curve, for diverging and converging channels, are very meager. When the flow through the channel is induced by the rotation of the channel itself about a central axis, other conditions are brought in so that the two cases are only in a measure comparable.

Experiments at the University of Wisconsin by the writer have shown that with radial vanes and a constant width of channel from entrance to exit of the impeller, a dead water space occurs on the rear sides of the vanes, and that filling these spaces with metal does not alter the results. The assumption that the entire cross-section of the impeller channel is utilized for discharge, with rectangular form of vertical velocity curve, may lead to serious error unless certain constants known from previous test are used and keep the error within practical limitations.

It is claimed by prominent German writers that by making the vanes of the impeller of the form of an involute of a circle, or of a combination of involutes and arcs of circles, the cross-section of the impeller channel can be made to increase gradually, and as a result the velocity relative to the impeller would decrease gradually. Other writers disregard this refinement, and for vanes curved backward use simply an arc of a circle for the form of the vanes.

Among the other questions on which experimental data are lacking may be mentioned the proper form for the diffusor vanes, the advisability of using guide vanes at the entrance to the impeller, and more detailed information as to the effect of the form of the impeller vanes on the increase in brake horsepower when the head is decreased.

A large amount of experimental information is in the possession of leading manufacturers of centrifugal pumps, and the intimate association of Mr. de Laval with The Henry R. Worthington Co. leads one to expect information in his book covering some of the disputed points in question.

The book has many valuable suggestions and the results of tests of installations carried out show the possibilities of centrifugal pumping machinery for many engineering problems.

The nomenclature in various parts of the book has not been made uniform, so is somewhat confusing. The typography is excellent, but the editing has apparently been hurriedly done and in this respect the book could have been greatly improved.

The book is of value to the designer for general information, and as showing a method of laying out curves for the impeller and diffusor vanes which have yielded good results in practice. To one who is looking for definite information for the fundamental principles of designing, in the way of comparative tests showing the effects of modification in design on characteristic curves, the book is somewhat of a disappointment.

THE ART OF ILLUMINATION — By Louis Bell, Ph. D., Fellow, American Academy of Arts and Sciences; M. A. I. E. E.; Past-President, The Illuminating Engineering Society; Vice-President, The Illuminating Engineering Society (London). Second edition, thoroughly revised, enlarged and reset. New York and London: McGraw-Hill Book Co. Cloth; 6¾x9½ in.; pp. ix + 353; 171 text figures. $2.50, net.

Ten years ago when Dr. Bell presented the first edition of his "Art of Illumination," it was the pioneer text in this field and he was one of the few who recognized the hygienic and esthetic sins that were being committed under the name of "illumination." His book set forth so well the advantages of better and more attractive lighting that it must take credit for no little of the interest that began to be aroused.

In the ten years that have elapsed, an illuminating engineering society has sprung up and illuminating engineers of more or less ability are to be found in practically every city of the land. A great reform has taken place among the fixture manufacturers and the types of monstrosities which used to stick out from walls and hang down from ceilings have been relegated to the designers' scrap heaps. Radically new types of electric arc and incandescent and mantle gas lamps have been evolved and artificial lighting is on a higher plane than when Dr. Bell's treatise first appeared. Under these conditions the first edition, of course, has proved inadequate as a guide for readers who desire to investigate the status of the art, but so well was the original work planned and executed that even the very considerable additions of data and experience which have been made have not seemed to change the general character and appearance of the work; only careful reading of paragraph after paragraph shows how complete has been the revision. The general resemblance between the two editions must be attributed also in part to the fact that the general principles underlying the art of illumination have remained the same in spite of a wider appreciation and application.

The book first discusses "light and the eye," falling back time and again to the knowledge which the medical profession has given us. This is followed by a

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chapter on the discussion of the production of colors and the relation of various colors to common lighting. Next is outlined the general laws of reflection and diffusion, and an outline of the practice of photometry. The chapters on materials of illumination, incandescent burners, electric incandescent and arc lamps, on shades and reflectors are largely historical and descriptive as would be expected. Up to this point the reader has traversed a little more than half the volume. The rest of the book discussing domestic illumination, the lighting of large interiors and exteriors and the means of illuminating for decoration may be regarded as expounding the art and science of "illuminating engineering" as it is generally understood today.

During the interval between the appearance of the two editions of Dr. Bell's work naturally a large number of treatises on illuminating engineering, or various subdivisions, have appeared. However, the original work was well planned and the revision seems to have been thorough, so that the new form of the older work seems to hold as important a place in engineering literature as did the original.

THE OFFICIAL GOOD ROADS YEAR BOOK OF THE UNITED STATES—Published by the American Association for Highway Improvement; J. E. Pennybacker, Jr., Secretary and Editor, Colorado Bldg., Washington, D. C. Cloth; 6x9¼ in.; pp. viii + 445. Gratis to members; to nonmembers, $1, net.

This year book, the first of its kind, is the work of the comparatively new American Association for Highway Improvement. It contains a great quantity of information regarding roads, which we presume will not be repeated in the coming volume, and also some very interesting and valuable statistics and data on road construction in the various states during the past year.

The contents include a preliminary history of road building, a description of the American Association of Highway Improvement, a 147-page résumé of road legislation in the United States up to the first of the present year, a copy of the suggested state aid bill which has been drafted by the United States Office of Public Roads, descriptions of various types of roads and highway bridges, lists of bond issues, appropriations for and mileage of roads in the various states and also a résumé of the amount of convict labor in the different states, patents issued in 1911 pertaining to roads, trade names of road materials, a bibliography of road and bridge construction, a list of the associations concerned with road work and manufacturers and contractors in the same line. For a first effort the book is remarkably good. We presume that next year the editors will have some difficulty in filling as large a number of pages, but the new volume continued on the basis established in the present one will form a valuable addition to every engineer's library.

CONCRETE AND STUCCO HOUSES—The Use of Plastic Materials in the Building of Country and Suburban Houses in a Manner to Insure the Qualities of Fitness, Durability and Beauty. By Oswald C. Hering, M. A. I. A. New York: McBride, Nast & Co. Cloth; 7½x10¼ in. Pp. 105. $2, net.

The stucco and concrete house has undoubtedly come to stay. The growing shortage in suitable timber is probably the most pronounced factor in the increased use of these new materials, but their adaptability to domestic architecture and, where properly designed, their relative freedom from fire risk both warrant a prediction of an increased use in the future. The principal objections to their substitution for the old-fashioned timber construction are their higher cost and the opportunity they afford for the exercise of extremely bad architecture. Furthermore, artisans who are capable of executing good concrete and stucco work are few, compared with those who are familiar with the regulation timber construction. It is to be expected that when time goes on the cost of such buildings will be reduced with the increased knowledge among masons and builders in the matter of their construction, but the errors in design and specification, for which the architects are responsible, must be cured first. Mr. Hering's book is directed toward this end. He addresses the architect primarily, but also those prospective owners who wish to utilize this new form of construction. For the builder it will be of little use, because it disregards most of the intimate details of the construction itself.

The first chapters of the book are devoted to an exposition of the development of country and suburban residence districts, not so much as regards the individual architecture of the houses, but the general layout of streets, lots and woodland area. The next few chapters take up the general subject of concrete and of stucco from a historical and descriptive viewpoint. There follow chapters upon the essentials of stucco on wood frame, stucco on masonry, and stucco on concrete blocks, each of which is illustrated by drawings, showing the details of these various types. The final chapters are on furring, fire-resisting construction, reinforced concrete, the physical and esthetic possibilities of concrete, and the general subject of American architecture.

As noted above, technical descriptions of the methods of building concrete or stucco work are not the main portions of the book. It is rather a general treatise, intended to edify the architect and lay reader and to educate them up to the possibility of concrete or stucco for residence building. The book is accompanied by a number of photographs of houses of the type discussed and with some few drawings showing the methods of applying stucco to various kinds of framing.

An Old Friend in a New Dress

FORNEY'S CATECHISM OF THE LOCOMOTIVE—Third edition. Revised and enlarged by Geo. L. Fowler, Consulting Mechanical Engineer. New York: Railway Age Gazette. (Selling Agents, McGraw-Hill Book Co., New York City.) Cloth; two volumes; 6x9 in.; pages 644 and 293; 477 and 199 cuts in text, and four folding plates. $3, net, per copy; $5 per set.

"Forney's Catechism" is a work of historical interest as well as technical value and has been a notable work for nearly 40 years. This new book is the "catechism" as written by Mr. Forney, modified and brought down to date so as to cover modern developments and such features as the Mallet locomotive, the mechanical stoker, the superheater, and the Walschaerts valve gear (which last is modern only in its adoption in American practice). The first edition appeared in 1873, and the second (revised and rewritten) in 1889; both of these were by Mr. Forney, and we are pleased to see the simple brief preface of each included in the new edition which has been prepared, revised and enlarged by Mr. Fowler. The author explained that he wrote for "plain people" and his clear and concise writing, with but a minimum of mathematics and technicalities, has been followed as far as possible in the revision. The book is largely for the ambitious apprentice, the engine runner, fireman, trainman and mechanic who seeks to advance himself by his knowledge. It is an excellent book also for the student and the railway official, and a book of reference for the mechanical engineer. There is no other book which so clearly and thoroughly explains the principles and practice of locomotive construction and operation. But the book gives a very practical caution in regard to technical studies in the following statement:

"It should always be remembered that the mere buying of books contributes very little knowledge to the owner. It is the reading and understanding of them which increases knowledge."

Part I (644 pages) is the practical section of the catechism, dealing with the various parts of the locomotive: their construction, functions and operation. Also the various fittings and appliances; the running and care of the engine; and the questions of compounding and combustion. Considerable space is devoted also to the air brake and its operation. Part II (293 pages) is devoted mainly to the theoretical side of the subject, which is treated more extensively than in the original for the reason that it has become more important with the increase in size and power of the locomotive engine and the requirements for economy in its

operation. It covers the principles of mechanics and their application to the mechanism of the locomotive; the expansive action of steam and the utilization of this action in the engine (through the boiler and valve gear); and such other related matters as friction, lubrication, brake action and train resistance.

The book is printed in a neat, clear type and is well illustrated.

ADDRESSES TO ENGINEERING STUDENTS—Edited by Waddell & Harrington, Consulting Engineers. Second edition. Kansas City, Mo.: Waddell & Harrington. Cloth; 6x9½ in. Pp. 563. $1 for single copies obtained from editors direct, 75c. when distributed in quantities through universities or colleges.

The first edition of Messrs. Waddell & Harringtons' noteworthy compilation of engineering addresses, an edition of 3000 volumes, was exhausted within three months of its issue. This very complimentary reception of a book intended not as a money maker for its editors, but for the general edification of the profession, has led the editors to undertake this publication of a second edition of 8000 copies. The conditions of sale are the same as those noted in the first edition reviewed in ENGINEERING NEWS, Oct. 12, 1911, viz., $1 per copy for individuals and 75c. per copy in numbers for the use of engineering students.

The second edition contains all the addresses published in the first, and, in addition, five new papers by Drs. Snow and Du Bois, Dean Damon and Prof. Karapetoff, the latter having two papers. Further revision consists in adding to the preliminary paragraph to each address a short statement of the career of the author of the address and an account of the place and date of its delivery.

As we stated in our previous review, the engineering profession is greatly indebted to the editors of this compilation. Engineers are not, as a rule, known as orators, essayists, or rhetoricians, and it is good for the profession to realize that there are a great number of its members who have the gifts of speech and thought generally accredited to be the sole possessions of the brother professions of law and religion. A great engineer must always be known by his deeds and not by his words; but the younger men in particular and the profession in general may well profit by the words of men the greatness of whose deeds is known by all.

BUILDING STONES AND CLAYS—Their Origin, Characters and Examination. By Edwin C. Eckel, C. E., Assoc. M. Am. Soc. C. E., M. Soc. Chem. Indus., F. Geol. Soc. Am. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 6x9¼ in.; p. xv + 264; 37 text figures; 115 tables. $3, net (12/6, net).

It is to be feared that most engineers who use building stones are not interested in those stones further than in the tests for their strength and durability. If they wish to inquire further into the history of the material, we know of no better book for the purposes than this new one by Mr. Eckel. The first part of the book is devoted to building stones and the second to clays. Chapter 1 is a general geological description of the origin and structure of rock. Chapters 2 to 10 are devoted respectively to igneous rock in general, granite, and other acid igneous rocks, trap rock and other basic igneous stones, serpentine and soapstone, sedimentary rocks in general, slate sandstone, limestone and marble. In each of these chapters the origin and composition, a description of the physical properties and a note on the distribution and production of the various stones are given. The remainder of the portion on building stones is devoted to field examination and valuation of stone properties, which chapter is a discussion of the financial possibilities in quarries and methods of investigating their worth. There is a final chapter on laboratory testing of stone.

The part on clays consists of a chapter on general classification of clays, residual clays, transported clays, distribution of clays, and field examination of clay deposits. The book is well illustrated throughout, and well supplied with tables giving analyses of the various stones and statistics of their production and distribution. Another value is added by a bibliography at the end of each chapter devoted to such books as would give the reader a more detailed and complete knowledge of the subject to which the chapter is devoted.

THE CHAMPLAIN TERCENTENARY—Report of the New York Lake Champlain Tercentenary Commission. Prepared by Henry Wayland Hill, LL. D., Secretary of the Commission. Albany, N. Y.: Pub. Doc. Cloth; pp. viii + 534; 82 illustrations.

In this bulky volume are printed the complete proceedings in connection with the celebration of the 300th anniversary of Champlain's discovery of the lake which bears his name. The celebration was conducted under the joint auspices of the States of New York and Vermont. The federal government coöperated with an appropriation and was represented by President Taft and numerous other high officials. The Department of State also gave official invitations to representatives of Great Britain, France and Canada. The celebration was a noteworthy and dignified affair and is worthily commemorated in this volume.

THE ENGINEERING INDEX ANNUAL FOR 1911—Compiled from the Engineering Index published monthly in "The Engineering Magazine" during 1911. New York and London: The Engineering Magazine. Cloth; 6½x9½ in.; pp. xxx + 499. $2, net.

The review of the 1910 volume of this book appeared in ENGINEERING NEWS of Apr. 13, 1911, and our readers are referred to that issue for a full statement of the scope and general makeup of this annual engineering index.

One oversight, which we believe has not been pointed out before, is the failure to state in the preface exactly what period is covered by each volume. In the present volume, in looking for several important articles published in November, 1911, we fail to find any references to them.

On closer examination we are led to believe that the index covers the year Nov. 1, 1910, to Nov. 1, 1911, although the preface states that this index "brings the investigator down to the close of 1911." This is obviously misleading to a searcher who wishes to locate a particular article which he remembers was published in a certain year.

Publications Received

[So far as possible the name of each publisher of books or pamphlets listed in these columns is given in each entry. If the book or pamphlet is for sale and the price is known by the editor the price is stated in each entry. Where no price is given it does not necessarily follow that the book or pamphlet can be obtained without cost. Many, but not all, of the pamphlets, however, can be secured without cost, at least by inclosing postage. The amount of postage necessary can be estimated approximately from the stated size of the book or pamphlet and the number of pages it contains. Reprints of papers read before engineering societies and printed by the authors for private circulation can often be obtained without cost by addressing the author, whose name and address is always given when known. Persons who are in doubt as to the means to be pursued to obtain copies of the publications listed in these columns should apply for information to the stated publisher, or in case of a reprint of a society paper to the author of the paper. The stated American prices of foreign books are based on 40 cents per shilling and per mark for British and German books, respectively, and 30 cents per franc for French books, the extra allowances being for importation costs.]

ADDRESSES AND DISCUSSIONS AT THE CONFERENCE ON SCIENTIFIC MANAGEMENT—Held at Tuck School, Dartmouth College, Oct. 12-14, 1911. Hanover, N. H.: The Amos Tuck School of Administration and Finance, Dartmouth College. [Selling agents: The Weekly Bulletin Publishing Co., 183 Essex St., Boston, Mass.] Cloth; 6x9 in.; pp. 388. $2.50, net; by mail, $2.75.

ADDRESSES TO ENGINEERING STUDENTS—Edited by Waddell & Harrington, Consulting Engineers. Second edition. Kansas City, Mo.: Waddell & Harrington. Cloth; 6x9½ in.; pp. 563. $1 for single copies obtained from editors direct, 75c. when distributed in quantities through universities or colleges.

THE AMERICAN LUMBER INDUSTRY—Official Report, 10th Annual Convention, National Lumber Manufacturers' Association, Held in Cincinnati, Ohio, May 7-8, 1912. Chicago, Ill.: The Association (Leonard Bronson, Manager; Stock Exchange Bldg.) Cloth; 6x9½ in.; pp. 238. $1, net.

AMERICAN PUBLIC HEALTH ASSOCIATION, LABORATORY SECTION—Standard Methods for the Examination of Water and Sewage. Second edition. New York: The Association, 289 Fourth Ave. Cloth; 6½x9¾; pp. vi + 144. $1.25, postpaid.

ANNALES DES MINES DE BELGIQUE—Tome XVII, 2me Livraison. [V. Watteyne, Inspecteur général des Mines, a Bruxelles, Secrétaire.] Brussels, Belgium: Pub. Doc. Paper; 6½x10 in.; pp. 366; one folding map.

BOARD OF HEALTH, CITY OF ORANGE, N. J.—Annual Report, 1911. G. H. Richards, M. D., President. Pub. Doc. Paper; 6x9 in.; pp. 55.

BUILDING AND FLYING AN AEROPLANE—A Practical Handbook Covering the Design, Construction and Operation of Aëroplanes and Gliders. By Charles B. Hayward, M. The Aëronautical Society, and Society of Automobile Engineers. Chicago, Ill.: American School of Correspondence. Cloth; 5½x8½ in.; pp. viii + 142; 52 text figures. $1, net.

BULLETINS, COMMONWEALTH BUREAU OF CENSUS AND STATISTICS, MELBOURNE—Published under authority of the Minister for

Home Affairs by G. H. Knibbs, C. M. G., Commonwealth Statistician. Melbourne: Pub. Docs. Paper; 8¼x13 in.

No. 2—Official Statistics, Commonwealth of Australia. Monthly Summary of Australian Statistics, February, 1912. Pp. 40.

No. 4—Social Statistics. Statistics as to Education, Hospitals and Charities, and Law and Crime, for 1910. Pp. 72.

No. 5—Transport and Communication. Summary of Commonwealth Statistics of Transport and Communication, 1901-1911. Pp. 41.

No. 7—Census Bulletin. Census of the Commonwealth of Australia, Apr. 3, 1911. Length of Residence in Australia. Pp. 8.

BULLETINS, MILWAUKEE BUREAU OF ECONOMY AND EFFICIENCY—Milwaukee, Wis.: The Bureau, John E. Treleven, Secretary. Paper; 6x9 in.; illustrated.

No. 16: Water Works Efficiency—3. Operating Efficiency. By Ray Palmer. Prepared under the Direction of B. M. Rastall [Director]. March 15, 1912. Pp. 35.

No. 18: Health Department—3. Communicable Diseases. By Selskar M. Gunn. Prepared under the direction of John R. Commons [Director]. April 15, 1912. Pp. 40.

No. 19: Eighteen Months' Work of the Milwaukee Bureau of Economy and Efficiency—By John R. Commons. Apr. 15, 1912. Pp. 44.

BULLETINS, UNITED STATES GEOLOGICAL SURVEY—Geo. Otis Smith, Director. Washington, D. C.: Pub. Docs. Paper; 6x9 in.

Nos. 471-B and C: Advance chapters from Bulletin 471, "Contributions to Economic Geology, 1910, Part II."

B—Coal on Dan River, North Carolina. By R. W. Stone. Pp. 35; 1 plate and 4 text figures.

C—Lignite in the Fort Berthold Indian Reservation, North Dakota, North of Missouri River. By Max A. Pishel. Pp. 19; 2 plates.

No. 506—Geology and Mineral Resources of the Peoria Quadrangle, Illinois. By J. A. Udden. Washington, D. C.: Pub. Doc. Paper; 5¾x9 in.; pp. 103; 9 plates (2 maps in pocket of cover) and 16 text figures.

Nos. 520-B and K: Advance chapters from Bulletin 520, "Mineral Resources of Alaska, 1911."

B—Tin Resources of Alaska. By Frank L. Hess. Pp. 6.

K—Geologic Investigations Along the Canada-Alaska Boundary. By A. G. Maddren. Pp. 20.

Nos. 530-F, L and M: Advance chapters from Bulletin 530, "Contributions to Economic Geology, 1911, Part I."

F—Alunite in the San Cristobal Quadrangle, Colorado. By Esper S. Larsen. Pp. 7.

L—Graphite near Raton, New Mexico. By W. T. Lee. Mica in Idaho, New Mexico and Colorado. By D. B. Sterrett. Pp. 22; 3 illustrations.

M—Notes on the Northern La Sal Mountains, Grand County, Utah. By J. M. Hill. Pp. 22; 1 map.

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